FINAL ENVIRONMENTAL ASSESSMENT/ 90 PERCENT PLAN FOR TOBICO MARSH

SAGINAW RIVER/BAY NRD SETTLEMENT
BAY CITY, MICHIGAN

Submitted To:
United States Fish and Wildlife Agency, Region 3

Prepared For:
Tobico Marsh Restoration Work Group

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1.0 INTRODUCTION

1.1 PURPOSE

This document presents the Environmental Assessment/Final Plan for the hydrologic restoration of the Tobico Marsh. The Purpose of the project described in this Environmental Assessment/Final Plan is to facilitate to the extent practicable, natural fluctuations of water levels within Tobico Marsh, while providing adequate flood protection to residences riparian to Tobico Marsh. The Site Plan for the Tobico Marsh is presented on Figure 1.1.

1.2 NEEDS

The Tobico Marsh restoration project is being undertaken in partial fulfillment of the obligations of General Motors, the City of Bay City, and the City of Saginaw (Defendants) for enhancement of resource use and public education and outreach pursuant to the Saginaw River and Bay Natural Resource Damage (NRD) Consent Judgment (Consolidated Cases 98-CV-10368 BC). The Trustees are working with the Defendants to ensure the project is completed in accordance with the Consent Judgment. The Trustees include the Secretary of the Interior as represented by the U.S. Fish and Wildlife Service, the Saginaw Chippewa Tribe, the Director of the Michigan Department of Environmental Quality (MDEQ), and the Attorney General of the State. The primary need of the project is to meet the requirement of the Consent Judgment. Paragraph 7.8 states:

> "*<u>Resource Restoration - Fisheries Habitat Improvement</u>. To enhance fishery resources of Saginaw Bay and Tobico Marsh (part of the Bay City State Recreation Area), Defendants shall submit within thirty (30) days after the third (3rd) anniversary of the entry of this Consent Judgment to the Trustees for approval of an initial plan to restore and thereafter restore, in accordance with the approved final plan, fisheries habitat in the Tobico Marsh and to increase the recreational fishing opportunities provided by the Tobico Marsh. Defendants shall not be obligated to expend more than Five Hundred Thousand Dollars ($500,000) under this Paragraph 7.8 and the approval plan hereunder.*"

The Tobico Marsh Restoration Work Group (Group) was established in July 2001 to formulate the scope of work and conduct restoration activities for the Tobico Marsh restoration. Section 6 presents the members of the Group. The Group agreed that the Environmental Assessment/Final Plan for Tobico Marsh would consist of a summary of available information, status report/plan on data collection, analysis of data, a description of next steps including an evaluation of selected restoration alternatives, and an environmental assessment.

Further needs addressed within this report include:

- a need to provide improved fish passage;
- a need for an automated method to close the flap gate during periods of high lake water;
- a need to improve flushing of the marsh to assist in keeping to outlet to the lake open;
- a need to ensure that flooding potential of riparian low lying residences is not increased and possibly reduced;
- a need to improve habitat management strategies; and
- a need to assist in restoring the hydrology of the altered system.

1.3 DECISION REQUIREMENTS

The Trustees would make the final decision on which action to implement. As a federal agency and one of the Trustees, the U.S. Fish and Wildlife Service (Service) needs to select an alternative that satisfies the following requirements:

- best meets the goals of the natural resource damage and restoration process;
- complies with the requirements of the Consent Judgment;
- fulfills the intent of the settling parties;
- benefits natural resource while minimizing any harm that might occur in the process;
- is supported by the local community;
- complies with all applicable laws and ongoing site-specific remedial action plan requirements;
- is feasible; and
- is cost-effective.

Then the Service must determine whether the proposed action would result in a substantial impact upon the human environment, necessitating an Environmental Impact Statement, or if a Finding of No Significant Impact (FONSI) is appropriate.

1.4 BACKGROUND

The Tobico Marsh is located along the western shoreline of Saginaw Bay approximately 5 miles north of Bay City, Michigan and encompasses approximately 900 acres of open water and vegetated wetland (Figure 1.1). The Tobico Marsh is separated from Saginaw Bay by a narrow sand spit with only a narrow outlet at the southern end of the marsh. The size of the outlet changes due to fluctuations in the bay and marsh water levels. Flow in the outlet channel is greatest during periods of heavy rainfall or during spring snowmelt. At other times, flow is intermittent to virtually nonexistent. At the time of this writing, Lake Huron water levels were near historic recorded lows and flow from the outlet is often as a seep through the sand of the beach to Saginaw Bay. The outlet was excavated in 1986 to facilitate drainage from Tobico Marsh during periods of heavy rainfall. The channel has since filled in due to ongoing sediment deposition from longshore currents as discussed in Section 4.0. Surrounding land use is principally agricultural, with the communities of Brisette Beach, Kilarney Beach, Little Kilarney Beach, and Tobico Beach located on the sand spit to the east of the marsh. Water levels and water flow within the marsh are dominated by surface water runoff from surrounding agricultural lands and water control structures within the marsh drainage area, including county drains.

The Tobico Marsh Restoration Group was established in July 2001 to formulate the scope of work and conduct restoration activities for the Tobico Marsh restoration. Members of the Group are presented in Section 6.0. During its first meeting on July 11, 2001, the Group concluded that the language in the Consent Judgment does not constrain the restoration to spawning habitat for Northern Pike. The Group also agreed that the settlement amount of $500,000 should be used to "facilitate to the extent practicable, natural fluctuations of water levels within Tobico Marsh, while providing adequate flood protection to residences riparian to Tobico Marsh". The Group also agreed that it is important to consider other ecological restoration projects and projects that would enhance public use, as appropriate.

On January 30, 2002 the Tobico Marsh Public Scoping Meeting was held at the Bay City State Recreation Area Visitor's Center Auditorium. The purpose of the meeting was to solicit public input regarding potential actions for the restoration of the Tobico Marsh. Some common issues discussed at the meeting include flooding potential, marsh habitat, and potential impacts from the Hartley & Hartley landfill. Appendix A presents the minutes of the meeting.

The Initial Plan for Tobico Marsh restoration was submitted on July 1, 2002 and the 50 Percent Plan was submitted in January 2003. Both plans were subsequently approved by the Trustees.

The draft Environmental Assessment/90 Percent Plan was released to the public on March 4, 2004. The draft Environmental Assessment/90 Percent Plan was presented and discussed during a public meeting on March 10, 2004. A Site visit was conducted on April 7, 2004 with a local resident unable to attend the March 10, 2004 public meeting. Based on public comments and the Site visit, flow alterations at the north end of the marsh proposed in Alternative 4 do not appear to be feasible. The Group has selected Alternative 3 as the preferred alternative. All of the other elements of Alternative 4 are the same as Alternative 3, so selecting Alternative 3 instead of Alternative 4 only eliminates the re-routing of Hadd Drain from the original proposal.

2.0 DATA EVALUATION

In order to evaluate restoration alternatives, a thorough understanding of the hydrology of the marsh is essential. Initially, relevant available data were collected and evaluated. This was complemented by collecting data on water level, precipitation, and wind speed and direction at the marsh continuously. All of the data were evaluated to determine if adequate analysis could be conducted to develop suitable restoration alternatives. A summary of this analysis is presented in the following sections.

2.1 HISTORICAL SAGINAW BAY WATER LEVEL ANALYSIS

The ordinary high water mark for Saginaw Bay is 581.5 feet above mean sea level (ft AMSL IGLD). In January 2004, the average water level in Saginaw Bay was 577.12 ft AMSL IGLD with a maximum level of 577.91 ft AMSL IGLD.

Daily water levels for Lake Huron in Saginaw Bay have been recorded at the National Ocean Service (NOS) station in Essexville, Michigan (January 1953 through to February 2004).

The monthly average of the mean daily water levels for each month from January 1953 through to February 2004 are presented on Figure 2.1. Maximum and minimum daily levels for each month were only available from August 1977 through to February 2004 as presented on Figure 2.1.

Saginaw Bay water levels and in turn Lake Huron water levels are at the lowest levels that they have been since the early 1960s. The ground elevation of the outlet from the Tobico Marsh (through Tobico Lagoon) is approximately 580 ft AMSL IGLD. The current elevation of the water in the Saginaw Bay is below 578 ft AMSL IGLD. Due to these low levels, there is little hydraulic connection between the bay and the marsh. The water levels in Saginaw Bay are impacted by long-term trends affecting the entire Great Lakes system, however, substantial temporary fluctuations in levels can occur during high winds from the easterly or westerly directions. The water levels in Tobico Marsh are governed by short-term trends and more localized events.

The highest daily water level recorded for Lake Huron at the Essexville Station was 583.37 ft AMSL IGLD in May 1986. Prior to May 18, 1986, the lake levels were approximately 581.83 ft AMSL IGLD. A storm event occurred (2.3 inches), resulting in a rise in the lake level to 583.37 ft AMSL IGLD on the following day (May 19, 1986). It is believed that wind must have played a role in this substantial rise in water elevation, but wind data is not available. The water level in the lake returned back to 581.87 ft AMSL IGLD within 2 days.

During the early 1970s, water levels in Lake Huron were relatively high (approximately 580 ft AMSL IGLD) and during a storm with winds from the southeast, water from Saginaw Bay was pushed by the wind into the marsh up through the outlet and caused flooding of residents.

2.2 HISTORICAL FLOOD EVENTS

A letter dated November 23, 1917 from Mr. Peter Tierney of Tierney Brothers, Real Estate, Insurance and Loans describing a flood at Tobico Marsh is presented in Appendix B. It states that the Detroit & Mackinaw Railroad was washed out over the entire length of Tobico Marsh due to heavy rains and a wind from the northwest. This letter addresses the vulnerability of the marsh to a substantial flood (with winds from the west) event prior to any management activities, and further strengthens the need to monitor and manage the marsh appropriately to attempt to ensure that to the extent practicable an event like this does not occur in the future.

The most substantial recorded storm event was approximately 7.7 inches of rain over 24 hours on September 11, 1986 which greatly exceeds the 100-year, 24-hour storm event for Bay County (4.9 inches), and caused substantial flooding. The water level in Saginaw Bay was 581.93 ft AMSL IGLD on this day. Following this rain event, the water level rose to 582.15 ft AMSL IGLD and gradually decreased to water levels measured prior to the event.

2.3 FLOOD MAP ANALYSIS

A Flood Insurance Rate Map for Bay County, Michigan from the National Flood Insurance Program dated June 18, 1996 indicates that the area between Saginaw Bay and Tobico Marsh is Zone AE - Base flood elevations determined. The base flood elevation refers to the 100-year flood elevation, which has a 1 percent chance of being equaled or exceeded in any given year. There is a strip of land in between the Saginaw Bay and Tobico Marsh that is Zone X – Areas determined to be above 500-year floodplain.

The map indicates that the Base flood elevation in Saginaw Bay and Tobico Marsh is 586 ft AMSL using the National Geodetic Vertical datum (approximately 0.5 foot greater than IGLD). The land area east of the marsh and west of the bay would be flooded at this elevation except for a thin strip of land (see Appendix F).

2.4 REMOTE MONITORING DATA ANALYSIS

Remote monitoring equipment was installed and used to record precipitation, water levels, wind direction and wind velocity every 15-minutes at two remote sites and two local sites at the south end of Tobico Marsh at the locations presented on Figure 1.1. The main equipment is located in the vicinity of the flap-gate where precipitation, water levels, wind direction and wind velocity in the Tobico Lagoon (Local South - downgradient of the flap-gate) and Tobico Marsh (Local North - upgradient of the flap-gate) are monitored. Additional water levels were monitored in Tobico Marsh on the north (Remote North) and south (Remote South) sides of the former weir and were transmitted through wireless technology to the main equipment. The average water level in the marsh during the monitoring period (April 9, 2002 to September 16, 2003) was 580.7 ft AMSL IGLD. There was minimal fluctuation in marsh levels during the monitoring period, with a maximum level of 581.2 ft AMSL IGLD, and a minimum level of 579.9 ft AMSL IGLD. The data is summarized on Figure 2.3.

The data were evaluated to identify the impact of precipitation on water levels. In particular, the largest recorded precipitation event (approximately 1.1 inches over 24 hours) during this monitoring period resulted in a slight increase (approximately 0.3 foot) at the remote north location and a sharper increase at the remote south location (Figure 2.4). Water levels at both stations increased for 1 to 2 days following the event (due to direct precipitation, surface water runoff and shallow groundwater collection and removal from agricultural lands, which comprise a majority of the watershed) at which point they returned to pre-storm levels.

Other storm events of interest in Bay County include the September 1986 storm (7.7 inches), the 100-year 24-hour storm (4.9 inches), 10-year 24-hour storm (3.4 inches), and the 1-year 24-hour storm (2.4 inches).

The data were also evaluated to identify if there was any correlation between wind direction and speed to precipitation events as presented on Figure 2.5. No apparent correlation between these variables was observed over the monitoring period. It should be noted that prevailing winds are from the southwest. Approximately 11 percent of the time the wind is coming from the northwest and approximately 6 percent of the time the wind is coming from the southeast.

The wind velocity varies seasonally with higher readings in April, May, June, and July. The larger precipitation events were also recorded during the summer months.

The monitoring equipment continues to collect data.

2.5 RECENT TOPOGRAPHIC MAPPING

An aerial survey and topographic mapping was completed for the Marsh and adjacent properties. Aerial photography was completed on May 4, 2002. Figure 2.6 presents the aerial photograph.

Following the aerial photography, surveying was completed in order to generate an accurate topographic map of the marsh and its vicinity. The surveying included inverts of culverts, and other key features. Figures 2.7 to 2.16 present the topographic mapping.

Soundings (distance to bottom) were also completed throughout Tobico Lagoon and the large open water portion of the marsh. The maximum depth of Tobico Lagoon is approximately 10 feet. The water depth in the large open water portion of the marsh is fairly uniform at 2.2 feet. Cross-sectional drawings across the marsh identifying the bottom of the marsh (bathemetry) are presented on Figures 2.14 to 2.16.

This mapping component is important since it accurately identifies all features (houses, roads, culverts, ground surfaces) with respect to each other. Therefore, actual flood elevations can be determined as well as a hydraulic grade line (flow path) through the marsh which allow for adequate technical analysis of marsh hydraulics.

2.6 RESIDENTIAL FLOODING EVALUATION

The current open water in the marsh, the historic high water level measured at Essexville for Saginaw Bay, and the 100-year flood level (obtained from FEMA) are presented in Appendix F.

Houses susceptible to flooding adjacent to Tobico Marsh were identified by comparing the ground surface elevations to historical high water elevations in Saginaw Bay and the 100-year flood elevation identified by FEMA.

A total of approximately 250 such residences (both seasonal and permanent) were identified on the lands surrounding Tobico Marsh. A majority of the residences are situated to the East of the marsh, between the marsh and Saginaw Bay along Little Kilarney Beach, Kilarney Beach, and Brissette Beach. The following presents a summary of the elevations of the residences and other substantial elevations:

Elevation (ft AMSL IGLD)	*Percent of Houses In Elevation Range*	*Other Information*	*Implication*
582 - 584	17	May 1986 Saginaw Bay 583.37 ft AMSL IGLD	Approximately 17 percent of houses would likely be affected by the May 1986 high water.
584 - 586	52	100-year flood 585.5 ft AMSL IGLD	Almost 69 percent (17 percent plus 52 percent) of houses would likely be affected by high water during 100-year flood.
>586	31		All houses would be affected by high water during events exceeding 100-year flood.

Data collected from the Tobico Marsh water level monitoring system, NOS Saginaw Bay elevations (Essexville Station), and Flood Emergency Management Agency (FEMA) flood elevations were all used in the evaluation as follows:

- Tobico Marsh Elevations (April to June 2003):
  - Minimum of 579.9 feet AMSL IGLD,
  - Mean of 580.7 feet AMSL IGLD, and
  - Maximum of 581.2 feet AMSL IGLD;
- Saginaw Bay Elevations:
  - Minimum of 575.22 feet AMSL IGLD, October 2001 (August 1977 to February 2004),
  - Mean of 579.18 feet AMSL IGLD (January 1953 to February 2004), and
  - Maximum of 583.37 feet AMSL IGLD, May 1986 (August 1977 to February 2004); and
- FEMA 100-year Flood Level - 585.5 feet AMSL IGLD (June 1996).

In order to further evaluate existing Tobico Marsh conditions, including all critical elevations identified above, cross-section drawings through the marsh were completed based on recent survey information (May and October 2002) presented on Figures 2.7

to 2.16. The evaluation also utilized the recent topographic mapping and bathemetry of the marsh as well as the real time weather and water elevation data collected from within the marsh.

The following conclusions can be drawn based on the elevation data:

1. Approximately 69 percent of the residences are below the 100-year Flood Level (Appendix F) and these residences would not be protected from high water from Saginaw Bay by any control structure implemented in the marsh;
2. Fewer than 17 percent of the residences are on properties below the maximum observed water level in Saginaw Bay (583.37 ft AMSL IGLD) (Appendix F) and would likely be affected by an increase of less than 3 feet in current marsh water levels (i.e., elevation of 580.32 + 3 = 583.32 ft AMSL IGLD);
3. The lowest elevation of any resident between Saginaw Bay and Tobico Marsh is 582.41 ft AMSL IGLD; and
4. Therefore, any control structure or modifications (flap-gate) should be designed to maintain water elevations in the marsh below 582 feet AMSL IGLD, to the extent possible, therefore, minimizing the risk of adverse impacts from high water to any of the existing residents.

2.7 COUNTY DRAIN ANALYSIS

An area of approximately 4,280 acres currently drains (does not include Hadd Drain) into Tobico Marsh as described in the hydrologic analysis completed in Section 2.9.

2.7.1 HADD DRAIN

The Hadd Drain is located immediately north of the marsh and the discharge is currently pumped (capacity 9,800 gpm) directly to Saginaw Bay (see Figures 2.22 and 2.23). Using the 10-year, 24-hour design storm event, the peak flow expected to reach the Hadd Drain pumping station is approximately 100 cubic feet per second (cfs) [44,900 gallons per minute (gpm)] as presented in Appendix C. Currently, the peak flow that would pass through the three 18-inch corrugated steel, non-baffled, projecting circular culvert pipes at Parish Road would be expected to be approximately 50 cfs (26,940 gpm).

During field observations it was noted that all three of the culverts were in need of maintenance. Photographs presenting the existing conditions of each of the culvert pipes are presented on Figures 2.17 to 2.19.

2.7.2 PASSIVE DRAINS

A history of the repair and maintenance of the four passive county drains located to the west of Tobico Marsh was obtained from the Bay County Drain Commission and is presented in Appendix D. The locations and catchment areas for these drains are presented on Figures 2.22 and 2.23.

The Lesperence Drain was most recently cleaned out in 1982 and was sprayed in 1991 and 1997 with Garlon 3A (Dow Chemical) and Rodeo (Monsanto), respectively to control vegetation. The Dubay Drain was most recently cleaned out in 1996 and was sprayed in 1997. Wetters Drain was most recently cleaned out in 1985. Tobico Drain was most recently cleaned out in 1987, and sprayed in 1991. Based on historical records, Bay County drains are cleaned out every 10 to 20 years depending on the conditions of the drains.

Recent field observations indicate that minimal cleanout is needed in these drains at this time.

2.7.3 ACTIVE DRAINS

In addition to the Hadd Drain, the Van Alstine Drain is also a pumped drain. As needed, the drain is pumped into the Tobico Marsh using two pumps each capable of 9,000 gpm.

The Van Alstine Drain Subcatchment Area is 494 acres and is located to the south of Tobico Marsh and collects surficial runoff from residential, agricultural and forested areas which is then pumped (18,000 gpm capacity) into the Tobico Marsh (see Figures 2.22 and 2.23).

2.8 EVALUATION OF THE FLAP-GATE

The existing flap-gate at the Tobico Marsh as presented on Figure 2.20 is manually operated by turning a hand crank. The flap-gate is normally kept open in order to allow fish to freely move between the marsh and Saginaw Bay. However, under high water conditions in Saginaw Bay, especially with south-easterly winds, flow direction at the outlet can reverse whereby water from the Bay enters the marsh. When these reverse-flow conditions are combined with high influxes of water from precipitation or snow melt, the risk of flooding of properties situated around the marsh increases. In order to ensure that these conditions do not contribute to an increased risk in flooding, the flap-gate must be manually closed when such an event is anticipated, or when water levels are observed to be rising. Flap-gate maintenance has become an issue, due to tampering and a lack of manpower to properly maintain the flap-gate in the appropriate position. Bangor Township is responsible to operate and maintain the flap-gate.

2.9 HYDROLOGIC ANALYSIS

The National Resource Conservation Service (NRCS) Electronic Field Office Technical Guide (eFOTG) along with the Bay County Soil Survey (USDA, 1980), indicate that the sandy ridge along the eastern perimeter of Tobico Marsh consists of Pipestone-Tobico Fine Sands. This material comprises approximately 1.2 percent of all soil in the State of Michigan and in this area is typically saturated. Permeability of the soil is rapid in the range of approximately 6 to 20 inches per hour (at a depth of 8 inches) and is approximately 20 inches per hour (deeper than 8 inches), the available water capacity of the soil is very low, and the surface water runoff is very slow under normal conditions (SCS hydrologic group A if dry, D if wet). The water table is at or near the surface and the area is subject to frequent ponding. A copy of the relevant soil information is presented in Appendix E.

The eFOTG also indicated that the soils underlying Tobico Marsh are of the Belleville Loamy Sand group (ponded at the marsh and not ponded in areas surrounding the marsh), which comprise 6.3 percent of all soils in the State of Michigan. This material is typically saturated. This soil is formed of sandy deposits over loamy material. The permeability is rapid in the upper portion of the material (6 to 20 inches per hour up to 3 feet bgs) and moderately slow in the lower part (0.2 to 0.57 inches per hour greater than 3 feet bgs). The surface water runoff is very slow or ponded, therefore, most precipitation would infiltrate into the top 3 feet and then drain through tiling (SCS hydrologic group B at surface, D at depth) to County drains where it is routed back to the marsh.

An area of approximately 4,280 acres forms the Tobico Marsh watershed (Figure 2.22). This includes drainage through five county drains located west and south of the marsh, and drainage through the Tobico Marsh State Game Area and the marsh itself. Water enters the marsh as precipitation, groundwater flow, and surface water runoff.

For the purposes of this evaluation, it was determined that the groundwater flow entering the marsh was negligible and approximately equal to the groundwater exiting the marsh and was not included in further evaluations. This is a reasonable assumption since during periods of no rain, the water level in the marsh is stable, indicating the marsh is not filling or draining.

Based on average water levels measured in the marsh and recently completed sounding information, the current amount of water stored in the marsh is approximately 31 million cubic feet (710 acre-feet), over an approximate area of 322 acres of open water, at an average depth of 2.2 feet in the center part of the Marsh. The total storage capacity of the marsh up to an elevation of 582 feet AMSL IGLD (before any flooding would occur) is approximately 63 million cubic feet (1,450 acre-feet) or an average depth of 3.5 feet in the center part of the marsh.

Appendix E presents the 24-hour design storms that were obtained from the NRCS eFOTG for Bay County, Michigan. The Soil Conservation Services (SCS) Method (revised 1973) for estimating volume and rate of runoff in small watersheds was used for hydrologic evaluation purposes. The Tobico Marsh Watershed was divided into seven sub-catchment area (A through G) as follows:

A) Dubay Drain Subcatchment Area (567 acres): which is located at the most northern section of Tobico Marsh and collects surficial runoff as well as groundwater drained from agricultural land in the vicinity of Parish Road;

B) Wetters Drain Subcatchment Area (371 acres): which is located south of Dubay Drain and west of Tobico Marsh and collects surficial runoff as well as groundwater drained from agricultural land in the vicinity of Wetters Road;

C) Tobico Drain Subcatchment Area (401 acres): which is located south of Wetters Drain and west of Tobico Marsh and collects surficial runoff as well as groundwater drained from agricultural land in the vicinity of River Road;

D) Lesperance Drain Subcatchment Area (686 acres): which is located south of the Tobico Drain and west of the Tobico Marsh State Game Area and collects surficial runoff as well as groundwater drained from agricultural land in the vicinity of Schmidt Road and Jose Road;

E) Van Alstine Drain Subcatchment Area (494 acres): which is located to the south of Tobico Marsh and collects surficial runoff from residential, agricultural and forested areas which is then pumped (18,000 gpm capacity) into the Tobico Marsh;

F) Tobico Marsh State Game Subcatchment Area (864 acres): which is located to the southwest of the Tobico Marsh and collects surficial runoff from forested and marshy areas; and

G) Tobico Marsh (898 acres): which receives direct precipitation and is comprised of 322 acres of open water and 576 acres of marshy vegetated lands.

The Tobico Marsh Watershed Boundary, County Drains, and Subcatchment areas are presented on Figures 2.22 and 2.23.

Using soil groups, land use, and hydrologic soil cover complexes in the Tobico marsh watershed runoff curve numbers (CN) were developed. Runoff Curves are graphs generated for each soil type and given a number (i.e., CN 78). The runoff curves along with precipitation would give an estimation of flow. After flow is determined, a watershed lag is determined. Pre-developed graphs are utilized along with CN and furthest distance from subcatchment outlet to edge of subcatchment. The result is a time for peak flow to reach the subcatchment outlet. This data is determined for each subcatchment. All the data is analyzed to determine the peak flows for all subcatchments combined. All of the design parameters and calculation spreadsheets are presented in Appendix E. Peak flow values calculated were verified using the TR55 model from the NRCS with both ponding and non-ponding taken into consideration.

Based on a 10-year, 24-hour design storm (3.4 inches of rain), the peak flow expected through the flap-gate at the outlet of Tobico Marsh would be approximately 870 cfs (390,500 gpm) assuming that flow losses through the flap-gate are negligible and no storage (i.e., rise in water level) occurs in the marsh.

The current flap-gate structure consists of a flap-gate and an 8-foot diameter culvert pipe. Assuming unrestricted flow through the culvert, full pipe flow, and no losses, the structure is sufficient to handle flows of up to approximately 450 cfs (202,050 gpm). A design flow of 450 cfs would be insufficient for the peak flow of the 10-year, 24-hour design storm (870 cfs) as identified above. In an actual storm event the marsh would store a portion of the water which would effectively reduce the actual peak flow at the flap-gate.

If, during the 10-year, 24-hour storm, the precipitation entering the marsh from the entire watershed was stored (i.e., no flow through the flap-gate) water levels would rise in the marsh by approximately 1.9 feet to 582.6 ft AMSL IGLD (current marsh water level is approximately 580.7 ft AMSL IGLD).

The invert elevation of the 8-foot diameter culvert pipe located at the flap-gate is 578.35 ft AMSL IGLD. Therefore, the existing culvert pipe would only be half full with the 1.9-foot rise in water level and would discharge approximately 150 cfs (67,350 gpm) of flow from the marsh at that level. If the invert of the culvert pipe was lowered or the culvert was redesigned (i.e., rectangular instead of round) a greater flow rate could be achieved.

Complete reconstruction of the culvert to change elevation and/or width was not considered for further analysis because this approach would cost more than the funds available.

Please note that under current bay water levels (578.04 ft AMSL in June 2003), the marsh is continuously flowing/draining excess water to the bay, therefore, no flooding of residents would be expected to occur at current marsh levels and a 10-year 24-hour storm (i.e., marsh level would rise less than 1.9 feet).

In the event that bay levels were higher than the marsh (i.e., maximum recorded elevation of 583.37 ft AMSL IGLD in May 1986) and the marsh was not draining to the bay, minimal flooding may be caused by the bay to a small number of residences.

3.0 EVALUATION OF ALTERNATIVES, INCLUDING THE PROPOSED ACTION

The following is a description of potential alternatives for the restoration of the Tobico Marsh.

3.1 ALTERNATIVES NOT SELECTED FOR FURTHER ANALYSIS

An alternative not selected for further analysis was to construct a permanent channel to the bay from the Tobico lagoon. This would be the most costly of the options and would intrude on the character of the Saginaw Bay shoreline. The channel, although it could be as little as 10 feet in width, may pose a liability, especially for snowmobiles. Swimmers using the adjacent state recreation area beach, especially small children, could represent another liability concern. The structure may be unsightly and may not blend well with the character of the bay shoreline. Permitting by state and federal agencies may be a problem for this option. Also, a permanent channel located where long shore currents are working to form a sand split would be difficult to maintain because it opposes natural processes.

Complete reconstruction of the flap gate to change elevation and/or width was not considered for further analysis because this approach would cost more than the funds available.

3.2 ALTERNATIVES SELECTED FOR FURTHER ANALYSIS

Alternative 4 was the preferred alternative in the draft Environmental Assessment/90% plan released to the public on March 4, 2004, but Alternative 3 is the final preferred alternative. Based on public comments and the Site visit, flow alterations at the north end of the marsh proposed in Alternative 4 do not appear to be feasible. The Group has selected Alternative 3 as the preferred alternative. All of the other elements of Alternative 4 are the same as Alternative 3, so selecting Alternative 3 instead of Alternative 4 only eliminates the re-routing of Hadd Drain from the original proposal.

3.2.1 ALTERNATIVE 1 - NO ACTION

No water control or habitat alterations would be implemented. Current water control management and habitat management strategies would remain unchanged. The activities would include the continued manual operation of the flap-gate at Euclid Road.

Contamination from the Hartley & Hartley landfill may continue to affect the marsh until a final remedy for the landfill is implemented.

Implementation of this alternative would not affect the current risk of flooding or assist in restoring the marsh's hydrology.

3.2.2 ALTERNATIVE 2 - PERIODIC SEDIMENT CLEAN OUT

Minimal water control alterations would be implemented. The activities would include periodic cleaning of the culverts and removal of sediment, and the placement of riprap at both ends of the culverts under Parish Road (which may be completed by the Country Road Commission). The increase in flow through the marsh occurring as a result of this may impede or divert groundwater from the Hartley & Hartley landfill away from the marsh. In addition, the remote monitoring equipment would be maintained with access obtained at the State Recreation Area. These activities are estimated to have a capital cost of approximately $6,800 and an additional $2,000 per year for operation maintenance. The present worth cost of this alternative is $60,800.

Implementation of this alternative would restore the culverts to ensure sustained integrity and would allow increased flow through the Marsh from current conditions and should reduce flood potential.

In order to fund ongoing Operation and Maintenance (O&M), an account will be established or utilized. The account will be accessed by the Bay City State Recreation Area Park Manager. The Bay City State Recreation Area Park Manager will authorize the Bay County Road Commissioners to perform O&M activities. Upon successful completion of the activities, the Bay City State Recreation Area Park Manager will provide reimbursement to the Bay County Road Commission for the work performed from the account. The account would be funded with $53,997.30 by GM.

3.2.3 ALTERNATIVE 3 - ALTERATION OF FLAP-GATE STRUCTURE (FINAL PREFERRED ALTERNATIVE)

Flow control structures such as the flap-gate are managed so as to allow fish passage into and out of Tobico Marsh while managing water to minimize the risk of flooding to nearby residents. This alternative includes the components of Alternative 2 as well as proposing modifications to the flap-gate.

The existing flap-gate is manually operated. Flap-gate maintenance has become an issue, due to outside tampering and a lack of manpower to ensure that the flap-gate is in the appropriate position.

To alleviate this problem, a flap-gate enhancement design is proposed that would allow the existing flap-gate to be modified to automatically adjust to water levels during normal and flood conditions. The proposed modifications to the flap-gate would include adding counter balance weights on the backside (culvert side) of the gate as well as adding sealed drums containing closed cell foam mounted on a beam on the front side of the gate. The counter balance weights would be adjusted to keep the gate open at least 1-foot horizontally under normal flow conditions to allow fish in and out of the marsh. If the water level should rise on the Bay side of the flap-gate to a level that is above the water level in the marsh, the water would push the buoyant drums up which closes the gate. When the water level recedes, the gate would once again open. The counter balance weights may need periodic adjustment and the culvert may need cleaning from debris build-up but otherwise it is maintenance free.

A preliminary design has been completed as presented on Figure 2.21. This alternative would include alterations to the existing flap-gate. This would provide a more natural habitat for the marsh and for the fishery in the Tobico Marsh and still protect the residential areas from flooding.

The proposed upgrades to the existing culverts and the existing flap-gate are expected to have a capital cost of approximately $21,000 and an additional $2,700 per year for operation maintenance. The present worth cost of this alternative is $98,900.

Implementation of this alternative would restore the Parish Road culverts, increase flow through the Marsh, and provide access for fish movement between Saginaw Bay and the Marsh, while minimizing flood potential to residents.

In order to fund ongoing O&M, an account will be established or utilized. The account will be accessed by the Bay City State Recreation Area Park Manager. The Bay City State Recreation Area Park Manager will authorize the Bay County Road Commissioners to perform O&M activities. Upon successful completion of the activities, the Bay City State Recreation Area Park Manager will provide reimbursement to the Bay County Road Commission for the work performed from the account. The account would be funded with $77,710.40 by GM.

3.2.4 ALTERNATIVE 4 - ALTERATION OF FLOW AT THE NORTH END OF THE MARSH

This alternative includes the components of Alternatives 2 and 3 as well as re-routing the Hadd Drain into the marsh. Hadd Drain runs parallel to and north of Boutell Road and can be rerouted into the marsh by constructing culverts under Boutell Road. Additional culverts under Parish Road at the North (most upstream) section of the marsh would be required to transmit the greater flow into and through the marsh. This increased flow would contribute to the restoration of natural water flow conditions in Tobico Marsh and may result in enhanced opportunity for fish passage between the marsh and Saginaw Bay. The increase in flow would also slightly increase the potential for flooding of residents adjacent to the marsh. This would be accomplished by installing two new culverts, each with a peak flow capacity of 16 cfs, under each road.

The installation of culverts under both roads will ensure mounding of water does not occur in the north end of the marsh. Culvert installations will allow flow from the Hadd Drain to enter the marsh under Boutell Road and Parish Road. The flow rerouted from the Hadd drain would be up to 32 cfs (14,360 gpm).

The Tobico Marsh has an approximate area of 322 acres of open water (as of October 2002) and an additional 576 acres of marshy vegetation. Based on average monthly rainfall in Bay County, Michigan, the additional flow from the Hadd Drain would only cause an average water level elevation increase of approximately 1.5 inches over the entire marsh, assuming no outflow, minimal evapotranspiration, and relatively even distribution. Due to outflow, the average monthly water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be less than 1.5 inches. Based on the existing freeboard (maximum headwater depth) of approximately 3.5 feet above the Parish Road culvert pipes before water would flow over the road, the maximum flow capacity of the existing culverts is approximately 50 cfs (22,440 gpm). Based on this analysis if the Hadd Drain discharge was routed to the marsh, additional culvert flow capacity would be needed to handle this additional flow. In addition, historically there have been flooding problems with Parish Road due to inadequate culvert size, prompting the construction of the Oakwood and Hadd pump structures. The installation of two additional culverts under Parish Road will increase the total flow capacity at Parish Road to 80 cfs (35,900 gpm).

Using the 10-year, 24-hour design storm event, the peak flow expected to reach the Hadd Drain pumping station is approximately 100 cfs (44,900 gpm) as presented in Appendix C. The proposed culverts installed under Boutell road would have a total flow capacity of 32 cfs (14,360 gpm). The Hadd Drain pumping station would route the remaining flow (i.e., 68 cfs) into the Saginaw Bay.

Based on the 10-year, 24-hour design storm event in Bay County, Michigan, the entire flow from the Hadd Drain would cause an average water level elevation increase of approximately 4.0 inches over the entire marsh, assuming the Boutell and Parish Road culverts rout all flow from the Hadd Drain to the marsh, no outflow, minimal evapotranspiration, and even distribution. The peak flow of the 10-year, 24-hour design storm [100 cfs (44,900 gpm)] exceeds the capacity of the proposed Boutell Road culverts [32 cfs (14,360 gpm)], therefore a portion of the flow would be routed into the Saginaw Bay by the Hadd Drain pumping station. Due to the routing of flow into Saginaw Bay via the Hadd Drain pumping station and outflow the actual water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be less than 4.0 inches (since this would be the additional rise in the marsh water level elevation if the entire storm flow enters the marsh).

In the event of the 100-year, 24-hour design storm for Bay County, Michigan, the capacity of the Boutell Road culverts would be exceeded, as above. A similar flow to that occurring during the 10-year, 24-hour design storm would pass through the culverts, therefore, the water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be the same as discussed above. The Hadd Drain pumping station would route the additional flow into the Saginaw Bay.

This alternative would also reduce electrical usage because the re-routing of water from the Hadd Drain into the north end of the marsh would reduce the operation of the Hadd Drain pumps to high water levels only. The pumps would only run on demand during storm events.

The proposed upgrades to the existing culverts and the proposed new culverts to reroute flow into the marsh including the flap-gate upgrades are expected to have a capital cost of approximately $49,500 and an additional $4,100 per year for operation and maintenance. The present worth cost of this alternative is $167,600.

Implementation of this alternative would restore the Parish Road culverts, increase flow through the marsh, provide access for fish movement between Saginaw Bay and the marsh, while minimizing flood potential to residents through the installation of an automated flap gate. The increase in continuous flow of water through the marsh would result in an average water level increase of approximately 1.5 inches, however, it is not expected that an increase of this magnitude would affect flood potential.

3.3 SUMMARY OF PREFERRED ALTERNATIVE

The preferred alternative, Alternative 3, includes the following:

1. an upgrade of the flap-gate to allow for automatic control of the gate during normal marsh water levels and during storm events to prevent potential flooding from Saginaw Bay;
2. the cleaning of existing culverts under Parish Road which includes the placement of riprap around both ends of the culvert pipes;
3.

These activities would be completed concurrently and would be expected to cost approximately $98,900 to construct.

A cost comparison of the alternatives is presented in Table 3.1 and 3.2.

3.4 SUMMARY OF ALTERNATIVES

	Alternative 1 (No Action)	*Alternative 2 (Culvert Cleaning)*	*Alternative 3 (Final Preferred Alternative)*	*Alternative 4*
Components	No action	Periodic cleaning of culverts	Periodic cleaning of culverts	Periodic cleaning of culverts
	No needs addressed	Placement of riprap at both ends of Parish Road culverts	Placement of riprap at both ends of Parish Road culverts	Placement of riprap at both ends of Parish Road culverts
			An upgrade of the flap-gate to allow for automatic control	An upgrade of the flap-gate to allow for automatic control
				Construction of two culverts under Boutell Road to re-route flow from Hadd Drain into the marsh
Total Capital Costs	-	$60,800	$98,900	$167,600

4.0 AFFECTED ENVIRONMENT

4.1 PHYSICAL CHARACTERISTICS

Tobico Marsh is located along the western shoreline of Saginaw Bay approximately five miles north of Bay City, Michigan and encompasses approximately 900 acres of open water and vegetated wetland. The Tobico Marsh forms part of the Bay City State Recreation Area. The recreation area consists of nearly 5 miles of trails and two observation towers.

The Tobico Marsh is a direct result of historical geological events that formed the Great Lakes. The Great Lakes were formed during the most recent period of glaciation, that occurred some 18,000 years ago, when continental glaciers covered the region with ice thousands of feet thick. These glaciers acted as bulldozers, carving away the landscape and leaving behind deposits of fresh water as they melted. The glaciers moved slowly across the region removing rock and soil and then depositing them to the south.

Lake Huron and Lake Michigan were formed as softer rocks were more easily eroded. Glacial sediments deposited on the land, as well as eroded bedrock produced the beach materials that are found along the Great Lake shorelines today. At one time water levels in the Great Lakes were much higher then they are today. As water drained to the south and the east through the lake, various sandy shorelines were formed. Some of these shorelines were beaches that remained for a long enough period to allow accumulation of sand along ridges, like the one found along State Highway M-13 west of the Tobico Marsh.

The Tobico Marsh area was once a shallow water bay forming part of Saginaw Bay. The marsh was slowly closed off from Saginaw Bay at least 200 years ago by the formation of a sand spit caused by longshore currents. Longshore currents form along the shoreline in a manner consistent with prominent wind directions that cause water to approach the shore at an angle. Longshore currents can carry sand in shallow water parallel to the shoreline until an embayment is encountered. Embayments cause the longshore currents to widen and slows down sufficiently to lose the energy needed to carry the sand. The sand is then deposited to form a spit (a narrow finger-shaped extension of sand that gradually grows as longshore currents deliver more sand). A spit was formed between Tobico Marsh and Saginaw Bay which has isolated the marsh from the bay. The principal hydraulic connection that exists today between the marsh and the bay is a narrow outlet channel at the southern end of the marsh in the vicinity of Bay County State Recreation Area buildings.

Water enters the marsh primarily from County drains, surface water runoff, and direct precipitation, and flows through the marsh from north to south. Several culvert structures exist under roadways that cross through the marsh. Near the south end a manually operated flap-gate exists between the marsh and the lagoon. The purpose of the flap-gate is to prevent Saginaw Bay water from entering the marsh, which could flood residents during high water events with winds from the southeast. The water from the marsh normally flows from the lagoon to Saginaw Bay through the outlet. The amount of water flowing through the outlet depends on the flow of water through the marsh and the water level in Lake Huron.

The proposed actions involve areas in the immediate vicinity of the flap-gate and the culvert structures. These areas would have been previously disturbed in order to install the roads and associated culvert structures.

4.2 PHYSICAL WATER REGIME

Water levels and flow within the marsh have been manipulated to varying degrees since 1910 when a dam was used to retain water and attract waterfowl for hunting.

Figure 1.1 presents the Site Plan for the Tobico Marsh. The general flow of water in the Tobico Marsh is from north to south. Water north of Parish Road flows through three existing culverts before entering the large open water portion of the marsh. Flow then continues past the former weir/beaver dam location. A section of the weir has been removed, therefore, the weir no longer restricts flow. However, a beaver dam currently exists immediately downstream of the former weir. The beaver dam backs up water causing an increased water level in the large open water portion of the marsh. Once past the beaver dam, water flows through two box culverts under the Kilarney Beach Road then through the 8-foot diameter culvert and flap-gate on Euclid Road, into Tobico Lagoon and through the outlet into Saginaw Bay (Lake Huron).

There are three main inputs and outputs of water for the marsh. The three inputs consist of surface water runoff, groundwater flow, and direct precipitation. Similarly, the three main outflows of the marsh are surface flow, groundwater flow, and evapotranspiration.

Since 1950, the amount of open water in Tobico Marsh has increased from 136 acres to 322 acres, based on historical and recent aerial photography. The 2002 aerial photograph is presented on Figure 2.6.

During 1966, the Michigan Natural Areas Council revised and produced the Tobico Marsh Site Committee Report (MNAC Committee Report - Revised 1966), which eventually led to the dedication of the Tobico Marsh as a managed natural area by the Natural Resources Commission. During 1969, a topographic quadrangle map showing the Tobico Marsh State Game Area, a Tobico State Game Area map including geomorphic units and marsh character, and a Michigan Natural Features Inventory pre-settlement vegetation map of Bay County were published.

During the early 1970s, water levels in Lake Huron were relatively high (approximately 580 ft AMSL IGLD) and during a storm with winds from the southeast, water from Saginaw Bay was pushed by the wind into the marsh and caused flooding of residents. As a result, in 1974, a flap-gate and culvert structure were installed at the marsh outlet by the U.S. Army Corps of Engineers to alleviate flooding during certain wind events. When closed, the flap-gate allows water to exit, but not enter the marsh. When open, water moves freely into and out of the marsh. The flap-gate was removed by the Bay County Drain Commission in 1990 to help fish access the marsh, but it was reinstalled to prevent flooding.

4.3 BIOLOGICAL ENVIRONMENT

Muskrats and beavers are present in the Tobico Marsh. Suitable habitat for muskrats is usually in low flow or stagnant waters of depths between 1.5 to 4 feet. Trapping for these creatures in the Tobico Marsh continues.

The Tobico Marsh is also highly utilized as a migratory stop for waterfowl. This is primarily due to the lack of human disturbance in the area, the bountiful food supply, and because of the protection the marsh provides respite from the harsh weather experienced in Saginaw Bay. Ring-necked pheasants (*Phasianus colchicus)*, red-wing blackbirds (*Agelaius phoeniceus*), wrens (*Troglodytidae* spp.), bitterns (*Ardeidae* spp.), diving ducks (various species), Canada Geese (*Branta canadensis*), and the Michigan endangered King Rail (*Rallus elegans*) have been observed in the Tobico Marsh area.

Historically, the Tobico Marsh has been a valued spawning ground for northern pike (*Esox lucius*), yellow perch (*Perca flavescens*), and to a lesser degree largemouth bass (*Micropterus salmoides*), and recently common carp (*Cyprinus carpio*) and bowfin (*Amia calva*). Dense cattails, the varying depth of the marsh inlet/outlet corridor, and the installation of the flap-gate have limited the spawning potential for some fish such as northern pike in Tobico Marsh.

In April 1992, the MDNR adopted the 10-year "Tobico Marsh State Game Area Master Plan" (MDNR, 1992). In 1993, the opening from the Tobico Lagoon to Saginaw Bay was altered (moved from the north end to the south end) by the park manager due to previous fish strandings on the beach during spawning periods under certain wind events. During the period from 1994 to 2000, Tobico Marsh was the focus of several studies and management activities including studies of terrestrial, emergent, and submerged aquatic vegetation in the Tobico area, a survey of water and structure elevations, and a hydrologic study and a subsequent public meeting discussing the study. A fish study was performed by the MDNR in the Marsh above the weir, the Tobico Marsh Status of Fishery Resource Report was prepared, a flood insurance rate map for Bay County was prepared by the National Flood Insurance Program, and a map of the Tobico Marsh State Game Area was completed.

Flow in the outlet channel is greatest during periods of heavy rainfall or during spring snowmelt. At other times, flow is intermittent to virtually nonexistent. Lake Huron water levels are currently near historic recorded lows and flow from the outlet is often as a seep through the sand of the beach to Saginaw Bay. The outlet was excavated in 1986 to facilitate drainage from Tobico Marsh during periods of heavy rainfall. The channel has since filled in due to ongoing sediment deposition from longshore currents as previously discussed.

4.3.1 HABITAT/VEGETATION

Prior to settlement (by Europeans and others), the Tobico Marsh was a wooded coastal wetland. This habitat supported many creatures including bears, white-tailed deer, red-wing blackbirds, wrens, bitterns, and numerous others. When the logging period began (approximately 1836) much of the forest cover was removed, and the (previously forested) wetland areas no longer could support larger creatures such as bears. It is possible that the wetland may eventually become classified as a forested wetland again, as it is currently believed to be in the early to mid-successional state.

Cattails (*Typha sp.*) have always been prevalent in Tobico Marsh though the concentration of cattails has increased in the marsh over time. Cattails generally take root in waters with a maximum depth of 3 to 4 feet, and form floating mats if occurring in water deeper than that. Intermittent or dispersed cattails would be better for habitat than densely concentrated mats of cattails because densely concentrated mats of cattails can starve the underlying water of oxygen, nutrients, and light. For that reason, floating mats of cattails restrict the spawning activities of fish and the breeding of waterfowl. Cattail growth can be accelerated by run-off from fertilizers rich with nitrogen and phosphorous. Common muskrats (*Ondatra zibethicus*) are an important control mechanism for cattails as they use the plant to build lodges and consume cattails for food.

4.3.2 LISTED, PROPOSED, AND CANDIDATE SPECIES

An internal consultation with the East Lansing Field Office of the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act determined that no listed, proposed, or candidate threatened or endangered species or their critical habitats are found within the proposed action area (Appendix G).

4.4 LAND USE

The Tobico Marsh forms part of the Bay City State Recreation Area. The recreation area consists of nearly 5 miles of trails and two observation towers. Birdwatchers and naturalists enjoy the scenery of the marsh, and utilize the lookout points and nature trails. The land use is residential to the east and south of the marsh and agricultural (corn, sugar beats, potatoes, etc.) to the west and north of the marsh. The area is drained with County drains discharging to the marsh and bay.

4.5 NATIONAL AND LOCAL PROMINENCE

In 1976, the National Park Service placed the Tobico Marsh on the Registry of Natural Landmarks, and by 1983 it was identified as 1 of 19 damaged Natural Landmarks due to apparent contamination. This contamination originated from the Hartley & Hartley landfill and by 1985 part of Tobico Marsh was listed as a Superfund Cleanup Site by the State of Michigan. This was also identified during the public scoping meeting on January 30, 2002. At the time of this writing, the Michigan Natural Areas Registry classified approximately 30 acres of the Tobico Marsh Refuge as a critical area containing lakeplain, wet prairie and remnants of pin oak barrens. The MDNR began to re-evaluate its management practices of the Tobico Marsh as a wildlife refuge with limited public access, and began drafting a 10-year management plan for the State Recreation area (adopted 1992).

During the winter of 1987, a major fishkill was observed in the marsh due to excessive ice cover and subsequent depression in dissolved oxygen as reported in the Tobico Marsh Status of Fishery Resource Report (MDNR, 1997). In 1989 and 1990, Northern

Pike experienced difficulty during spawning after being stranded on the beach resulting from a change in wind direction (from south) and increased wind speed (40 mph).

Called "Petobeogong" or 'the little lake by the big lake' by the Chippewa First Nations, the Tobico Marsh was a valued hunting, fishing, and meeting ground for these people for many years. As settlement (by Europeans and others) of the Bay Area progressed, the area became more heavily exploited for natural resources such as trees and fish. Logging in the Tobico area started in 1836 and continued until 1887; also during this period, a thriving fishery was present in the Tobico area. The Tobico Marsh area was sold to the Tobico Hunting and Fishing Club in 1887 and in 1896 the Tobico Hunt Club was formed. This group's philosophy was one of restricted (sustainable) hunting such that the members could enjoy recreation in the area for years to come. During the time of ownership by the Tobico Hunt Club, minor construction in the Tobico area occurred including the installation of agricultural drains at numerous locations in the watershed (late 1800s to early 1900s), a dam probably located near the outlet (initially identified in correspondence dated 1910), and an eastern dike (1920) to maintain water level in the hunting area. During November 1917, a large storm washed out the D&M railway along the entire length of the marsh. In 1955, the Michigan Natural Areas Council created the Tobico Reconnaissance Committee to perform a natural inventory of the Tobico Marsh. In 1956, the newly formed State Wildlife Division acquired 869.9 acres of land that was previously under control of the Tobico Hunt Club and became the Tobico State Wildlife Refuge marking the beginning of public ownership for the marsh.

4.6 CULTURAL/PALEONTOLOGICAL RESOURCES

The work proposed in Alternatives 2 and 3 would involve the alteration of existing structures, including the flap-gate, and culverts under Parish Road. This work would not involve disturbing any natural soil profiles or potential historical areas. If Alternative 4 is chosen, additional culverts would be necessary under Parish Road and Boutell Road. These culverts would be constructed through the roadbed, which is not constructed of native soil. Therefore this work would not involve disturbing any natural soil profiles. Also note, any construction activities would be completed from existing man-made structures (roadways), and therefore the activities would not involve disturbing any native soil profiles.

The Group requested a State Historic Preservation Office (SHPO) review to ensure that no historic properties would be affected. The conclusion of the SHPO review is that no historic properties would be affected within the area of potential effects of the proposed alternative. The SHPO letter is presented in Appendix H.

4.7 LOCAL SOCIOECONOMIC CONDITIONS

This site is in immediate proximity to residences (vary from cottages to permanent homes) and farms (vary in size up to several hundreds acres). There is limited hydrologic impacts and an emphasis on flood control with all the alternatives, therefore it is not anticipated that there would be any affects on existing culture and paleontological resources.

4.8 ENVIRONMENTAL JUSTICE

The Executive Order 12898 on Environmental Justice issued by President Clinton on February 11, 1994, requires all federal agencies to assess the impacts of federal actions with respect to environmental justice. The Executive Order states that, to the extent practicable and permitted by law, neither minority nor low-income populations may receive disproportionately high and adverse impacts as a result of a proposed project.

The immediately surrounding population tends to be in local average income categories relative to that of the larger Bay City area, and no identifiable group of individuals can be considered to have lower income in relation to local averages. Minority populations are not known to be disproportionately represented in the vicinity of the proposed project.

5.0 ENVIRONMENTAL CONSEQUENCES

Several categories of environmental consequences are similar across the alternatives and are therefore discussed here rather than with each individual alternative in the following sections. No negative impacts to listed, proposed, or candidate threatened or endangered species or their critical habitats or to cultural or paleontological resources would be expected for any of the alternatives because these resources are not found within the proposed action area (refer to Sections 3.2), and the proposed activities are all limited to existing man-made structures. Appendix G presents the Section 7 form for listed species. With respect to environmental justice concerns, the impacts of the alternatives on human activities in the areas surrounding the project are expected to be minimal, and so do not represent any disproportionate high and adverse impacts to low-income and minority groups. Construction activities would occur in the areas identified on Figure 5.1. The park can remain open during implementation with only minor, short-term disruption to local road users. Alternatives 2, 3, and 4 would provide additional recreational opportunities, and a lower risk of flooding, for the immediate neighborhood.

5.1 ALTERNATIVE 1 - NO ACTION

5.1.1 PHYSICAL IMPACTS

No physical impacts would be made to the marsh.

The following physical needs would not be achieved:

- the need for an automated method to close the flap gate during periods of high water; and
- the need to assist in restoring the hydrology of the altered system.

5.1.2 HABITAT IMPACTS

No habitat impacts would be expected.

The need for an improved habitat management strategy would not be achieved.

5.1.3 BIOLOGICAL IMPACTS

No biological impacts would be expected.

The need for improved fish passage would not be achieved.

5.1.4 LAND USE IMPACTS

No land use impacts would be expected.

The following land use needs would not be achieved:

- the need to ensure that flooding potential of riparian low lying residences is not increased and possibly reduced; and
- the need to improve flushing in the marsh to assist in restoring the hydrology of the altered system and reduce impacts of water seeping from the Hartley & Hartley landfill.

5.1.5 CUMULATIVE IMPACTS

Under the "no action" alternative, a status quo is maintained. The marsh outlet would continue a natural progression to isolate the marsh from the bay and residents may be periodically flooded from the marsh under certain wind events and improper flap-gate operation.

5.2 ALTERNATIVE 2 – PERIODIC SEDIMENT CLEANOUT

5.2.1 PHYSICAL IMPACTS

No physical impacts would be made to the marsh, other that the required maintenance of existing culvert structures. The maintenance would consist of removal of debris using shovels and brooms at the inlets and outlet of the culverts and placing riprap at both ends of the structures. A total area of 20 square yards (yd^2) would be disturbed as compared to a total area of Tobico Marsh of 900 acres. Thus the disturbed area represents only 0.0005 percent of the Tobico Marsh area. Clearing passages through culverts would increase the continuous flow of water through the marsh, thus assisting in restoring the hydrology of the altered system.

The need for an automated method to close the flap gate during periods of high water would not be achieved.

5.2.2 HABITAT IMPACTS

The proposed action would have a positive impact on the marsh's habitat by increasing the continuous flow of water through the marsh. Continuous water flow increases the flushing of nutrients and maintains oxygen levels above those present in a static system.

5.2.3 BIOLOGICAL IMPACTS

Biological impacts would be limited only to those areas described above, or 0.0005 percent of the Tobico Marsh area. These impacts would be of short duration, as displaced organisms would be expected to recolonize disturbed areas in one to two growing seasons.

The need for an improved fish passage would not be achieved.

5.2.4 LAND USE IMPACTS

This alternative does not affect land use of the area.

This alternative would reduce potential flooding in the north end of the marsh and would increase the flow of water through the marsh. The increase in water flow would assist in restoring the hydrology of the altered system and reducing the impacts of water seeping from the Hartley & Hartley landfill.

5.2.5 CUMULATIVE IMPACTS

Alternative 2 involves cleaning out the existing culverts. This would have a positive impact in that the culverts would transmit more water than present but less than prior to road installation and would increase the opportunity for fish passage between the northern and central portion of the marsh. In addition, the potential cumulative impacts are also positive, if more or all culverts were kept clean they would allow fish passage, as appropriate. If culverts are not kept free of obstructions, fish passage would be restricted and water could backup and flood properties potentially adversely impacting wildlife and habitat.

5.3 ALTERNATIVE 3 – ALTERATION OF FLAP GATE (FINAL PREFERRED ALTERNATIVE) WITH ALTERNATIVE 2

5.3.1 PHYSICAL IMPACTS

The proposed action would include maintenance of existing culvert structures at Parish Road and upgrading the flap-gate at Euclid Road. The maintenance would consist of removal of debris and placing riprap at both ends of the structures. The flap-gate would be upgraded to allow for automated operation, normally open to allow fish passage, but closing during high water events to reduce the risk of flooding. Clearing passages through culverts would increase the continuous flow of water through the marsh, thus assisting in restoring the hydrology of the altered system.

5.3.2 HABITAT IMPACTS

The proposed action would have a positive impact on the marsh's habitat by increasing the continuous flow of water through the marsh. Continuous water flow increases the flushing of nutrients and maintains oxygen levels above those present in a static system.

5.3.3 BIOLOGICAL IMPACTS

The habitat changes described for this alternative are unlikely to substantially alter the use of this area by wildlife with the exception of improved fish passage. Since the flap-gate upgrade would result in the flap-gate being normally open, improved potential for fish passage would result. Fish would have increased spawning opportunities due to increased access to greater areas of the marsh.

5.3.4 LAND USE IMPACTS

This alternative does not affect land use of the area. Recreational fishing would be benefited to the extent that this alternative results in improved fish passage, for certain game fish species such as Northern pike, possibly resulting in increases in populations of adult Northern pike in Saginaw Bay. This alternative would reduce potential flooding to residents who live along the marsh to the east and north and would increase the flow of water through the marsh. The increase in water flow would assist in restoring the hydrology of the altered system and reducing the impacts of water seeping from the Hartley & Hartley landfill.

5.3.5 CUMULATIVE IMPACTS

Alternative 3 would have the cumulative impacts of Alternate 2 plus impacts associated with modifying the operation of the flap-gate. This would have a positive impact in that the flap-gate would operate automatically, therefore, allowing maximum fish passage while minimizing flood potential. In addition, the potential cumulative impact is also positive because if more flow control structures were automated, operation would be optimized and adverse impacts to wildlife and habitat would be minimized.

5.4 ALTERNATIVE 4 – ALTERATION OF FLOW AT THE NORTH END OF THE MARSH

5.4.1 PHYSICAL IMPACTS

The proposed action would include maintenance of existing culverts under Parish Road, the installation of two additional culvert structures at Parish Road, upgrading the flap-gate at Euclid Road, and re-routing water from the Hadd Drain into the north end of the marsh by installing two culverts under Boutell Road. Following installation, culverts will be maintained. The maintenance would consist of removal of debris and placing riprap at both ends of the culvert structures. The flap-gate would be upgraded to allow for automated operation, normally open to allow for fish passage but closing during high water events to reduce the potential risk of flooding. The water from the Hadd Drain would be diverted into the marsh by installing culverts under the existing road. The water currently carried in the Hadd Drain is pumped directly to Saginaw Bay. Re-routing water into the marsh would increase the amount of water flowing through the marsh, potentially assisting in flushing the marsh outlet and keeping it open. Several existing culvert structures within the marsh would need to be maintained, including cleaning and the installation of riprap. Clearing passages through culverts combined with re-routing water from the Hadd Drain into the north end of the marsh would greatly increase the continuous flow of water through the marsh, thus assisting in restoring the hydrology of the altered system.

5.4.2 HABITAT IMPACTS

The proposed action would have a positive impact on the marsh's habitat by increasing the continuous flow of water through the marsh. Continuous water flow increases the flushing of nutrients and maintains oxygen levels above those present in a static system. The average increase in water level is approximately 1.5 inches.

5.4.3 BIOLOGICAL IMPACTS

The habitat changes described for this alternative would be unlikely to substantially alter the use of this area by wildlife with the exception of improved fish passage. Since the flap-gate upgrade would result in the flap-gate being normally open, improved potential for fish passage would result. Fish would have increased spawning opportunities due to increased access to greater areas of the marsh. In addition, the greater flow of water through the marsh may assist in keeping the outlet to the bay open further enhancing fish movement.

5.4.4 LAND USE IMPACTS

This alternative does not affect land use of the area. Recreational fishing would be benefited to the extent that this alternative results in improved fish passage, for certain game fish species such as Northern pike, possibly resulting in increases in populations of adult Northern pike in Saginaw Bay. This alternative would reduce potential flooding of residences who live along the marsh to the east and north and would increase the flow of water through the marsh.

The increase in continuous flow of water through the marsh would result in an average water level increase of approximately 1.5 inches, assuming no outflow, minimal evapotranspiration, and relatively even distribution. Due to outflow, the average monthly water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be less than 1.5 inches. It is not expected that an increase of this magnitude would affect flood potential.

The installation of culverts under both roads will ensure mounding of water does not occur in the north end of the marsh. Culvert installations will allow flow from the Hadd Drain to enter the marsh under Boutell Road and Parish Road. The flow rerouted from the Hadd drain would be up to 32 cfs (14,360 gpm).

Using the 10-year, 24-hour design storm event, the peak flow expected to reach the Hadd Drain pumping station is approximately 100 cfs (44,900 gpm) as presented in Appendix C. The proposed culverts installed under Boutell road would have a total flow capacity of 32 cfs (14,360 gpm). The Hadd Drain pumping station would route the remaining flow (i.e., 68 cfs) into the Saginaw Bay.

Based on the 10-year, 24-hour design storm event in Bay County, Michigan, the entire flow from the Hadd Drain would cause an average water level elevation increase of approximately 4.0 inches over the entire marsh, assuming the Boutell and Parish Road culverts rout all flow from the Hadd Drain to the marsh, no outflow, minimal evapotranspiration, and even distribution. The peak flow of the 10-year, 24-hour design storm [100 cfs (44,900 gpm)] exceeds the capacity of the proposed Boutell Road culverts [32 cfs (14,360 gpm)], therefore, a portion of the flow would be routed into the Saginaw Bay by the Hadd Drain pumping station. Due to the routing of flow into Saginaw Bay via the Hadd Drain pumping station and outflow the actual water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be less than 4.0 inches (since this would be the additional rise in the marsh water level elevation if the entire storm flow enters the marsh).

In the event of the 100-year, 24-hour design storm for Bay County, Michigan, the capacity of the Boutell Road culverts would be exceeded, as above. A similar flow to that occurring during the 10-year, 24-hour design storm would pass through the culverts, therefore, the water level elevation increase in the marsh due to the additional flow from the Hadd Drain would be the same as discussed above. The Hadd Drain pumping station would route the additional flow into the Saginaw Bay.

This alternative would also reduce electrical usage because the re-routing of water from the Hadd Drain into the north end of the marsh would reduce the operation of the Hadd Drain pumps to high water levels only. The pumps would only run on demand during storm events. The increase in water flow would assist in restoring the hydrology of the altered system and reducing the impacts of water seeping from the Hartley & Hartley landfill.

5.4.5 CUMULATIVE IMPACTS

Alternative 4 would have the cumulative impacts of Alternative 3 plus the impacts associated with diverting additional water into the north end of the marsh. This would have a positive impact in that the water diverted into the marsh originally would have been part of the marsh. The additional water would improve flow through the marsh and should assist in maintaining the outlet of the marsh. In addition, routing additional water through the marsh would reduce sediment and nutrient loading to the Saginaw Bay, would also serve to dampen flood pulses to the Saginaw Bay, and would improve water quality in the Saginaw Bay. The marsh vegetation would effectively treat the nutrients in the runoff from the adjacent agricultural land instead of pumping it directly to the Saginaw Bay. The cumulative impact is positive since it would involve restoring natural drainage vs. man-made diversions. If natural drainage is restored, man-made impacts to wildlife and habitat could be slowly reversed, flood pulses in the Saginaw Bay would be dampened, and nutrient/sediment loading to the Saginaw Bay would be reduced. This would also improve water quality within the Saginaw Bay.

5.5 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

	Alternative 1 (No Action)	*Alternative 2 (Culvert Cleaning)*	*Alternative 3 (Final Preferred Alternative)*	*Alternative 4*
Physical Impacts	No area of the Marsh would be disturbed	Approximately 20 yd^2 of the 900-acre Marsh would be disturbed at the North end	Approximately 20 yd^2 of the 900-acre Marsh would be disturbed at the North end	Approximately 40 yd^2 of the 900-acre Marsh would be disturbed at the North end
	The flap-gate would not be improved	The flap-gate would not be improved	The flap-gate at the South end would be improved	The flap-gate at the South end would be improved
	Hadd Drain would not be rerouted	Hadd Drain would not be rerouted	Hadd Drain would not be rerouted	Hadd Drain would be rerouted through additional culverts under the road
	Bay water quality and flood pulses would not be improved	Bay water quality and flood pulses would not be improved	Bay water quality and flood pulses would not be improved	Improve water quality to Bay. Dampen flood pulses to Bay
Habitat Impacts	No disturbances would occur	Disturbances only in the 20-yd^2 area	Disturbances in the 20-yd^2 area	Disturbances in the 40-yd^2 area
	Water flow through the March remains constant	Increase water flow through the Marsh	Increase water flow through the Marsh	Increase water flow through the Marsh and increase water level across the Marsh
	Fish passage would not be improved	Fish passage would not be improved	Improved fish passage	Improved fish passage
	Plant diversity would not be increased	Plant diversity would not be increased	Plant diversity would not be increased	Increase plant life diversity
Biological Impacts	No disturbances would occur	Disturbances only in the 20-yd^2 area	Disturbances only in the 20-yd^2 area	Disturbances only in the 40-yd^2 area
	Fish passage would not be improved	Increased opportunity for fish passage between north and central portion of Marsh	Increased opportunity for fish passage between north and central portion of Marsh	Increased opportunity for fish passage between north and central portion of Marsh
	Fish spawning would not be improved	Fish spawning would not be improved	Increased fish spawning throughout the Marsh	Increased fish spawning throughout the Marsh

	Alternative 1 (No Action)	*Alternative 2 (Culvert Cleaning)*	*Alternative 3 (Final Preferred Alternative)*	*Alternative 4*
Land Use Impacts	Flooding potential would not be improved	Reduce flooding potential in the North end	Reduce flooding potential in the North end and along the East side	Reduce flooding potential in the North end and along the East side from surges from the bay, but slight potential for increased risk of flooding from Hadd Drain flow (1.5-inch water level rise)
	Recreational fishing would not be improved	Recreational fishing would not be improved	Improved recreational fishing	Improve recreational fishing and reduced electrical demand on Hadd Pump Station
Total Capital Costs	-	$60,800	$98,900	$167,600

6.0 LIST OF PREPARERS

Dr. Lisa Williams	United States Fish & Wildlife Service
Mr. Edward Peterson	General Motors
Mr. Joseph Medved	formerly General Motors
Mr. Jim Baker	Michigan Department of Natural Resources
Mr. Michael Evanoff	Michigan Department of Natural Resources
Mr. Doug Reeves	Michigan Department of Natural Resources
Ms. Barb Lercel	Michigan Department of Natural Resources
Mr. Jim Bredin	Michigan Department of Environmental Quality
Mr. Pieter Booth	Exponent
Mr. Michael Tomka	Conestoga-Rovers & Associates

7.0 CONSULTATION AND COORDINATION WITH THE PUBLIC AND OTHERS

This project was described in the Consent Judgment, which was announced in the Federal Register (November 30, 1998, Volume 63, Number 229, pages 65812-65813) and available for public comment for 30 days.

The Group consisting of the Service, along with the other trustees, the defendants and their consultants worked together to develop alternatives for this project.

The Service consulted internally with the Endangered Species Program staff at its East Lansing Field Office under Section 7 of the Endangered Species Act to determine if listed, proposed, or candidate threatened or endangered species or their critical habitats are found within the proposed action area.

A scoping meeting was held at Bay City State Recreation Area on January 30, 2002. The scoping meeting was advertised in MDEQ's biweekly newsletter and in the Bay City Times. Comments are presented in Appendix A. Attendees included representatives from the U.S. Fish and Wildlife Service, Michigan Department of Natural Resources, Michigan Natural Features Inventory, General Motors, Bangor Township, and a variety of surrounding land owners, business owners, and land users. The meeting included discussions regarding the selected alternatives, highlighting the associated advantages and disadvantages. Meeting attendees were encouraged to voice their concerns and leave comments for the Group to address. These comments were incorporated in this report.

The draft Environmental Assessment/90 Percent Plan was released to the public on March 4, 2004. The draft Environmental Assessment/90 Percent Plan was presented and discussed during a public meeting on March 10, 2004. A Site visit was conducted on April 7, 2004 with a local resident unable to attend the March 10, 2004 public meeting. Based on public comments and the Site visit, flow alterations at the north end of the marsh proposed in Alternative 4 do not appear to be feasible. The Group has selected Alternative 3 as the preferred alternative. All of the other elements of Alternative 4 are the same as Alternative 3, so selecting Alternative 3 instead of Alternative 4 only eliminates the re-routing of Hadd Drain from the original proposal.

8.0 PUBLIC COMMENT ON DRAFT EA AND RESPONSES

The following section summarizes the public comments and responses to the Draft Environmental Assessment.

Commenter	*Issue*	*Response*
Pat Beeson, Bay County Commissioner on behalf of landowners along Hadd Drain	Water levels in Hadd Drain are usually lower than those in Tobico Marsh.	We went on a site visit with Mr. Beeson and local landowners to examine the elevations in more detail. The commenters are correct, so we determined that re-routing Hadd Drain is not feasible and are recommending Alternative 3 instead of Alternative 4.
Anonymous (public meeting)	Increased water levels at north end of marsh	The final preferred alternative would not increase water levels at the north end of the marsh.
Anonymous (public meeting)	Ice impacts to flap gate operation	Water levels are generally low in winter unless water is actively flowing and the flap gate is constructed of heavy gauge steel, so ice is not expected to damage the flap gate or impair its ability to close in response to higher water levels on the bay side of the gate
Anonymous (public meeting)	Water depth in Tobico Lagoon	Altering the water depth in Tobico Lagoon is outside of the scope of this project and its funding source.
Anonymous (public meeting)	Contamination from Hartley and Hartley Landfill	We have consulted with MDEQ remedial project manager for the landfill. Nearly all soil and groundwater contamination at the site is contained by a hydraulic barrier system. Any increase in water flow through the marsh would assist in restoring the hydrology of the altered system and is likely to further reduce environmental risks from residual contamination outside the containment barrier associated with

Commenter	*Issue*	*Response*
		the Hartley & Hartley Landfill.
Anonymous (public meeting)	Plant debris in the outflow from the marsh to the beaches along the bay	By increasing the rate of flow through the marsh, the amount of plant debris exiting the marsh may increase slightly, although the difference in the amount of debris is expected to be negligible relative to the other sources of debris in inner Saginaw Bay.
Private citizen, written comment	Funds should be spent to restore beach for people to use rather than this project	The funds from this project are controlled by a consent judgment, so the funds must be spent to restore fisheries habitat in Tobico Marsh.
Private citizen, e-mailed comment	(a) Install another culvert at Tobico Lagoon (b)Too many cattails in marsh (c) Wetland at mouth of Tobico Lagoon is detrimental, convert the Lagoon to a harbor of refuge, install a launch ramp and channel with breakwall, need more piers and beaches between Bay City and Tawas	(a) We considered this alternative initially but it was beyond the scope of the available funding (see Section 3.1). (b) Other MDNR management activities will address the balance of cattails and other vegetation in Tobico Marsh (c) Addressing these issues is beyond the scope of this project based on the purpose and amount of funds available.
Private citizen, written comment	(a) Funds available for cleaning shoreline? (b) Will changes be monitored?	(a)The funds from this project are controlled by a consent judgment, so the funds must be spent to restore fisheries habitat in Tobico Marsh. (b) As part of the operation and maintenance component of the project, MDNR managers would evaluate the effectiveness of the project in the future.
Graduate student familiar with marsh	The beaver dam near the weir slows flow, so widening the	MDNR managers indicate that beaver dams are an ongoing issue for the

Commenter	*Issue*	*Response*
	opening could make dam building by the beavers less likely at this spot.	marsh and they will consider this and other alternatives to address beaver impacts on water levels and flow in the marsh.

9.0 REFERENCES

Department of Natural Resources Wildlife Division, April 1992. Tobico Marsh State Game Area Master Plan.

Federal Emergency Management Agency, June 18, 1996. Flood Insurance Rate Map, Bay County, Michigan.

Jennison Nature Center, 1987. Tobico Marsh, A Story of The Land and The People.

Michigan Department of Natural Resources, 1997. Status of the Fishery Resource Report, Tobico Marsh.

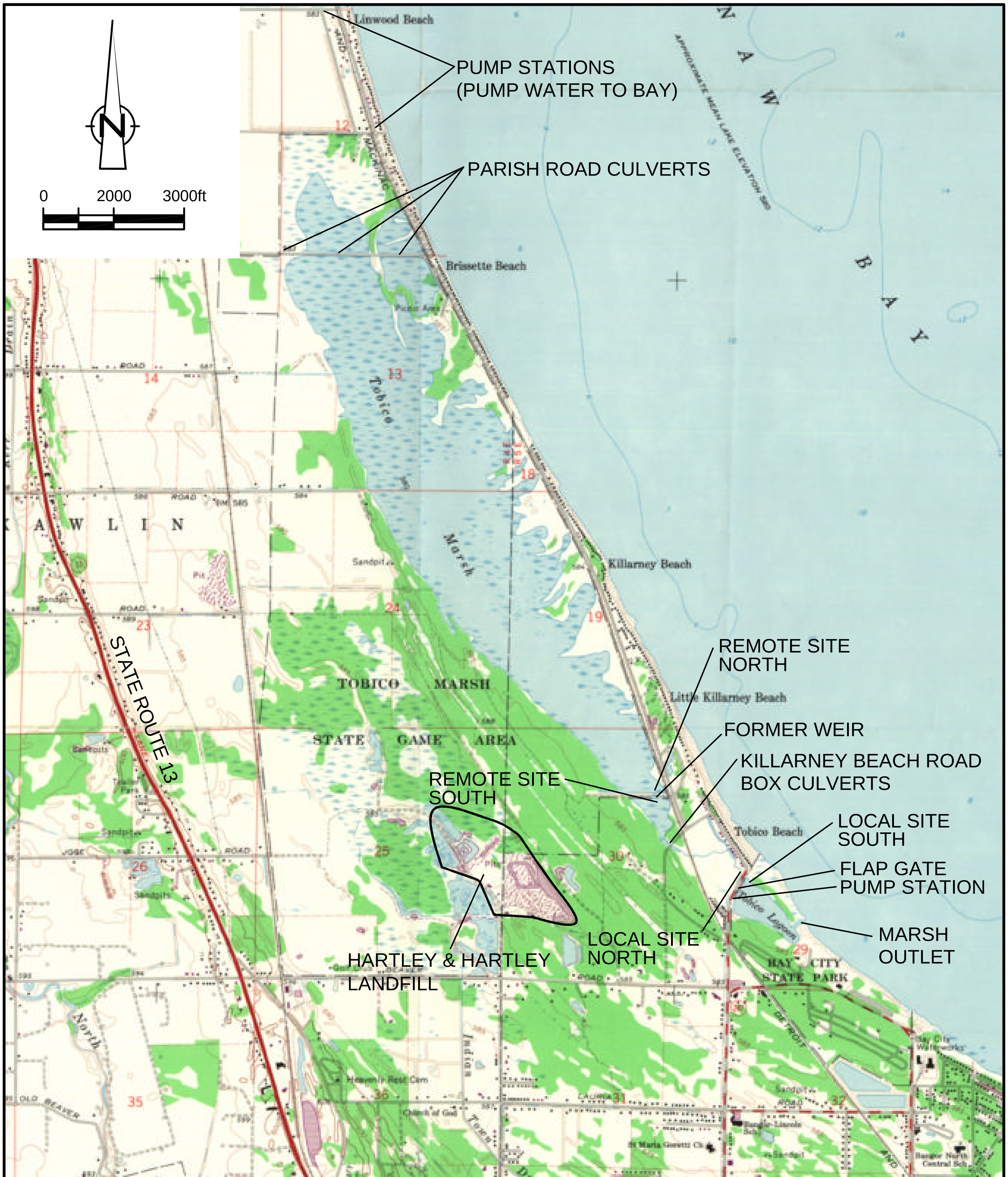
Resource Management Group, Inc., January 1995. Tobico Marsh Hydrologic Study.

Saginaw Valley State University, December 1994. Tobico Area Flora.

U.S. Department of Agriculture, Natural Resource Conservation Service, June 1986. Urban Hydrology for Small Watersheds (TR-55).

U.S. Department of Agriculture, Soil Conservation Service, April 1973. A Method for Estimating Volume and Rate of Runoff in Small Watersheds.

University of Michigan Museum of Anthropology and Saginaw Valley State University, January 1993. Lake Level Fluctuation and Prehistoric Hunters at Tobico Marsh.



SOURCE: USGS QUADRANGLE, KAWKAWLIN, MICH., 1967

figure 1.1

SITE PLAN
TOBICO MARSH
Saginaw River/Bay NRD Settlement

18204-03(013)GN-WA013 OCT 01/2004

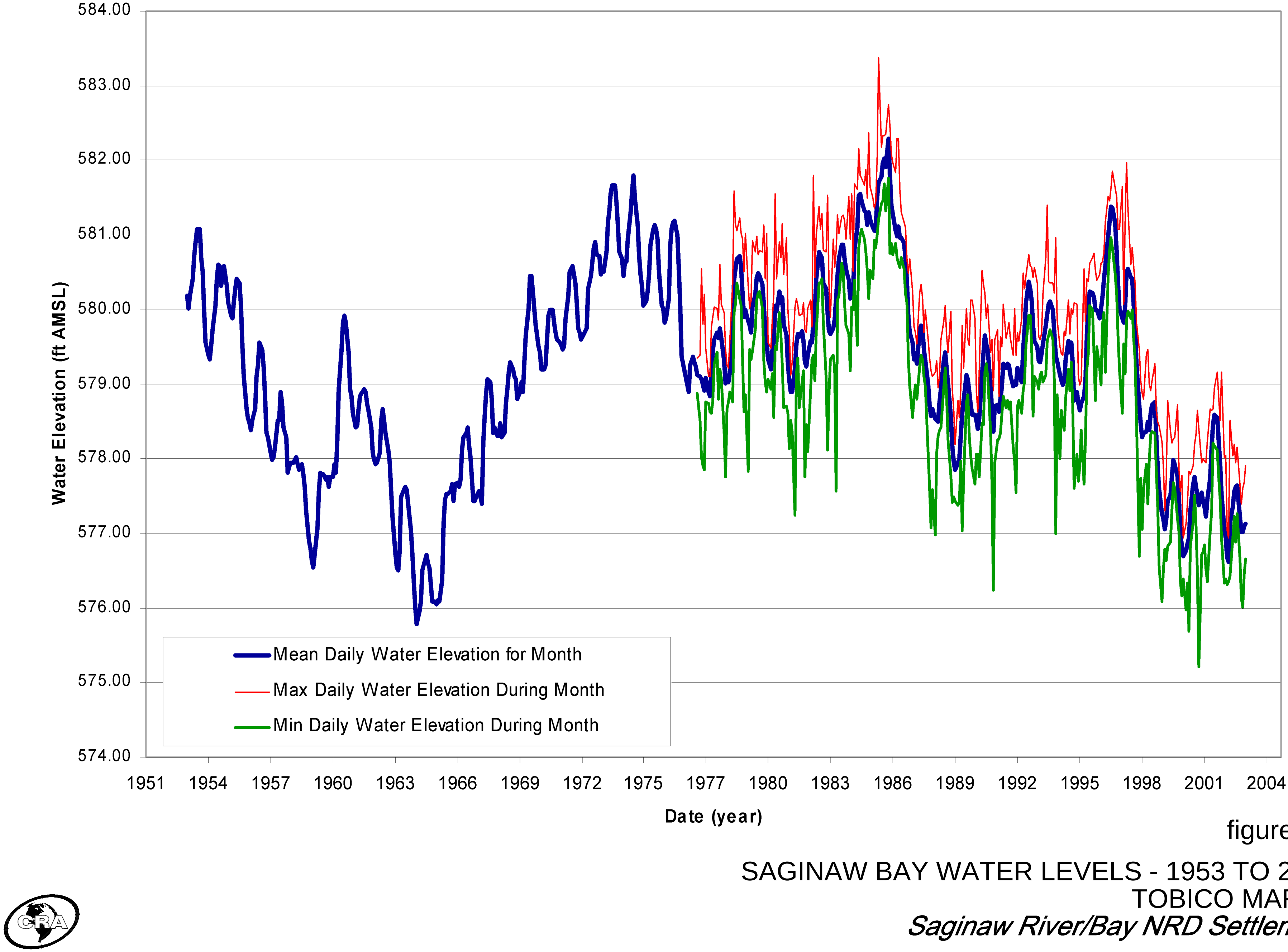
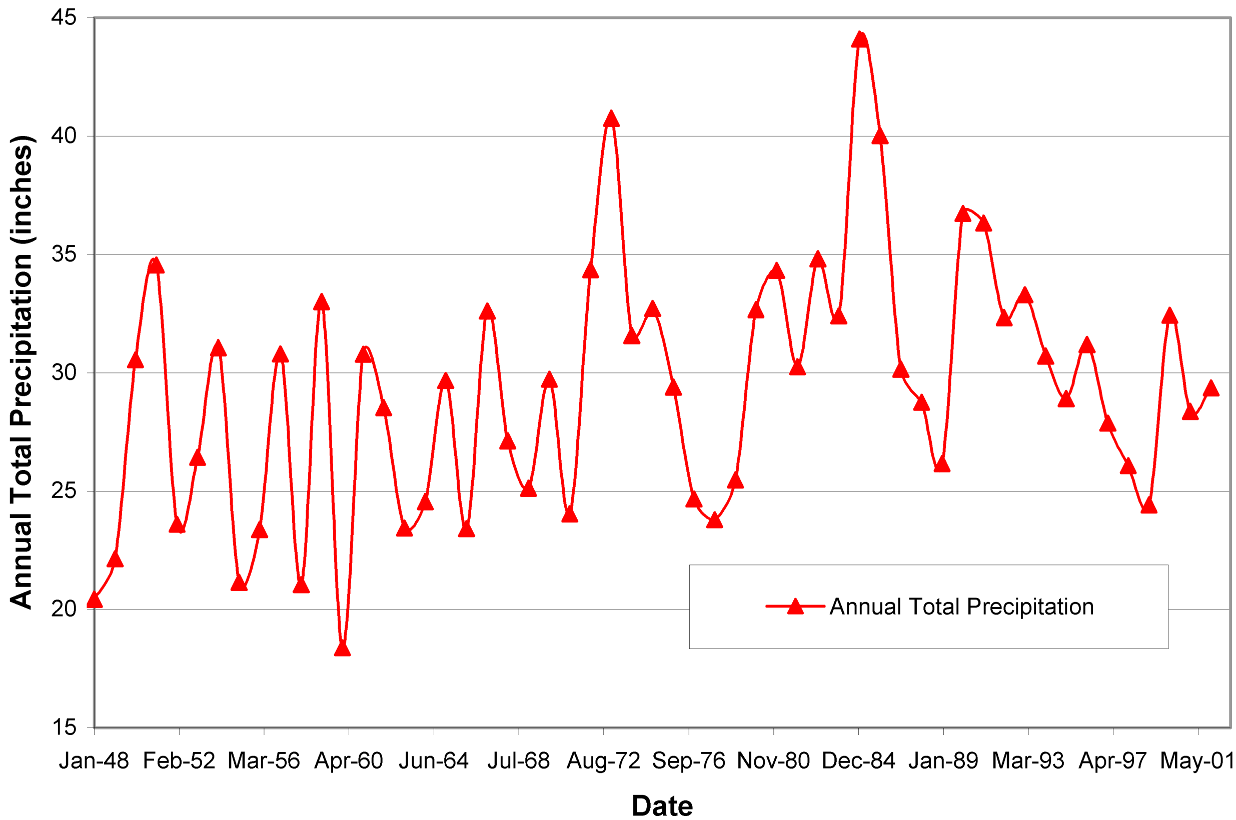


figure 2.1

SAGINAW BAY WATER LEVELS - 1953 TO 2004
TOBICO MARSH
Saginaw River/Bay NRD Settlement

18204-03(013)GN-WA002 OCT 01/2004



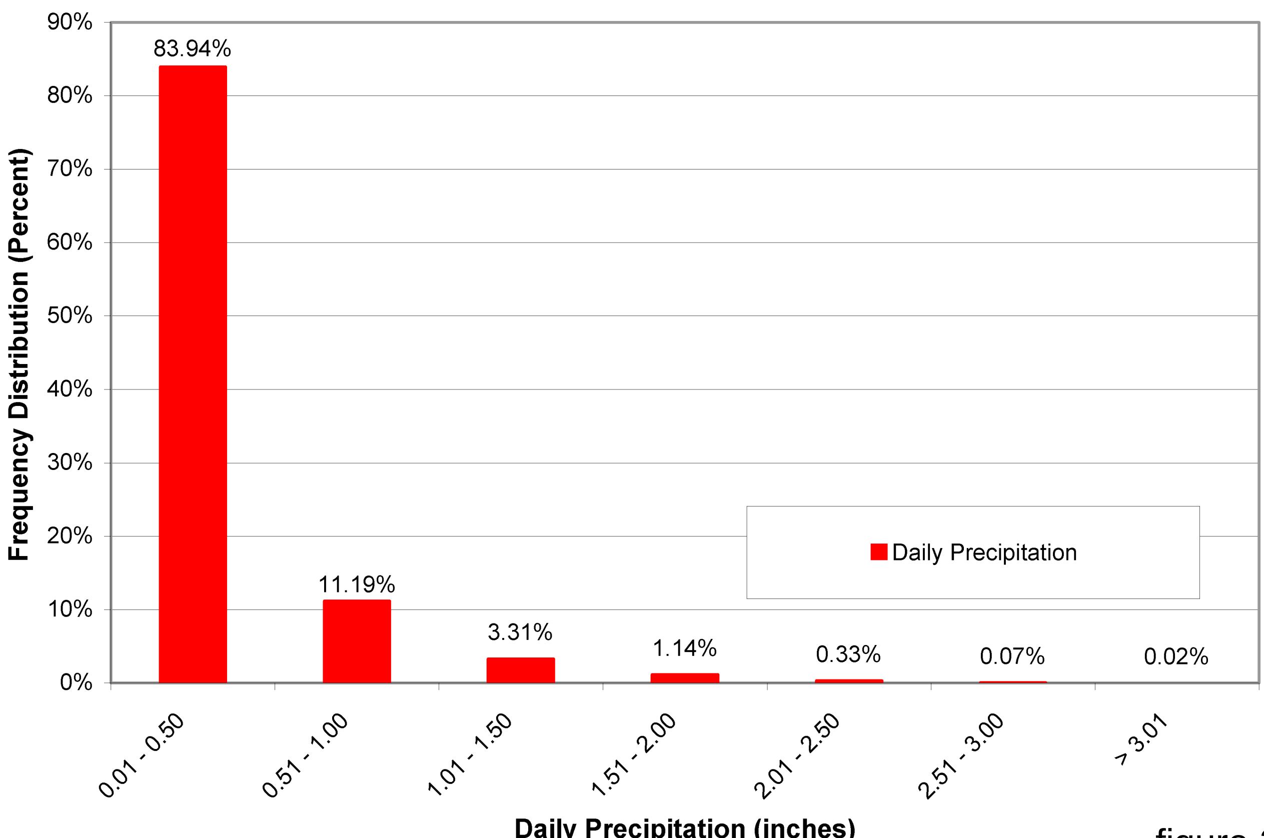


figure 2.2

RECORDED PRECIPITATION AT ESSEXVILLE - 1948 TO 2002

TOBICO MARSH

Saginaw River/Bay NRD Settlement

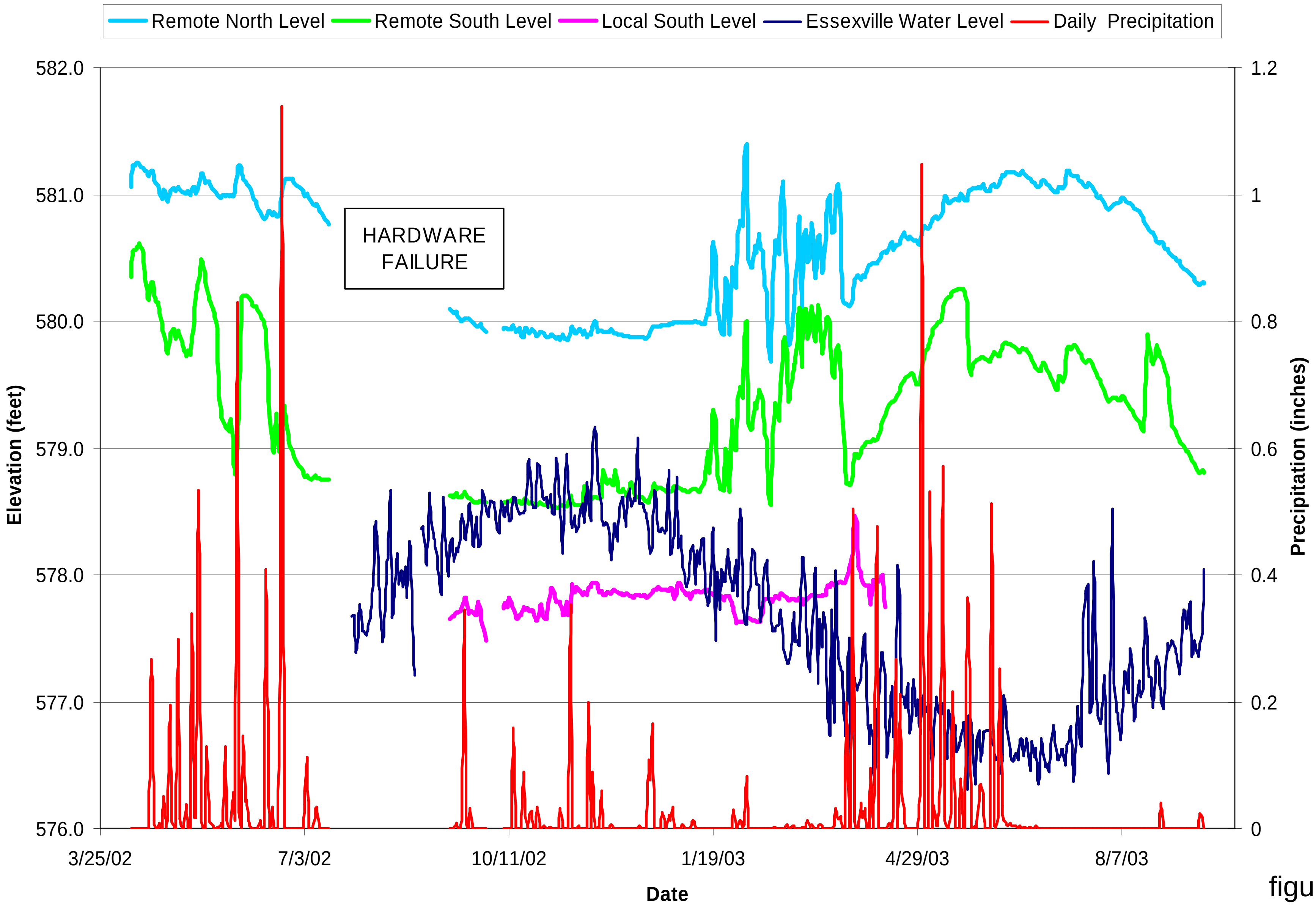


figure 2.3

2002-2003 REMOTE MONITORING SUMMARY
TOBICO MARSH
Saginaw River/Bay NRD Settlement

18204-03(013)GN-WA004 OCT 01/2004

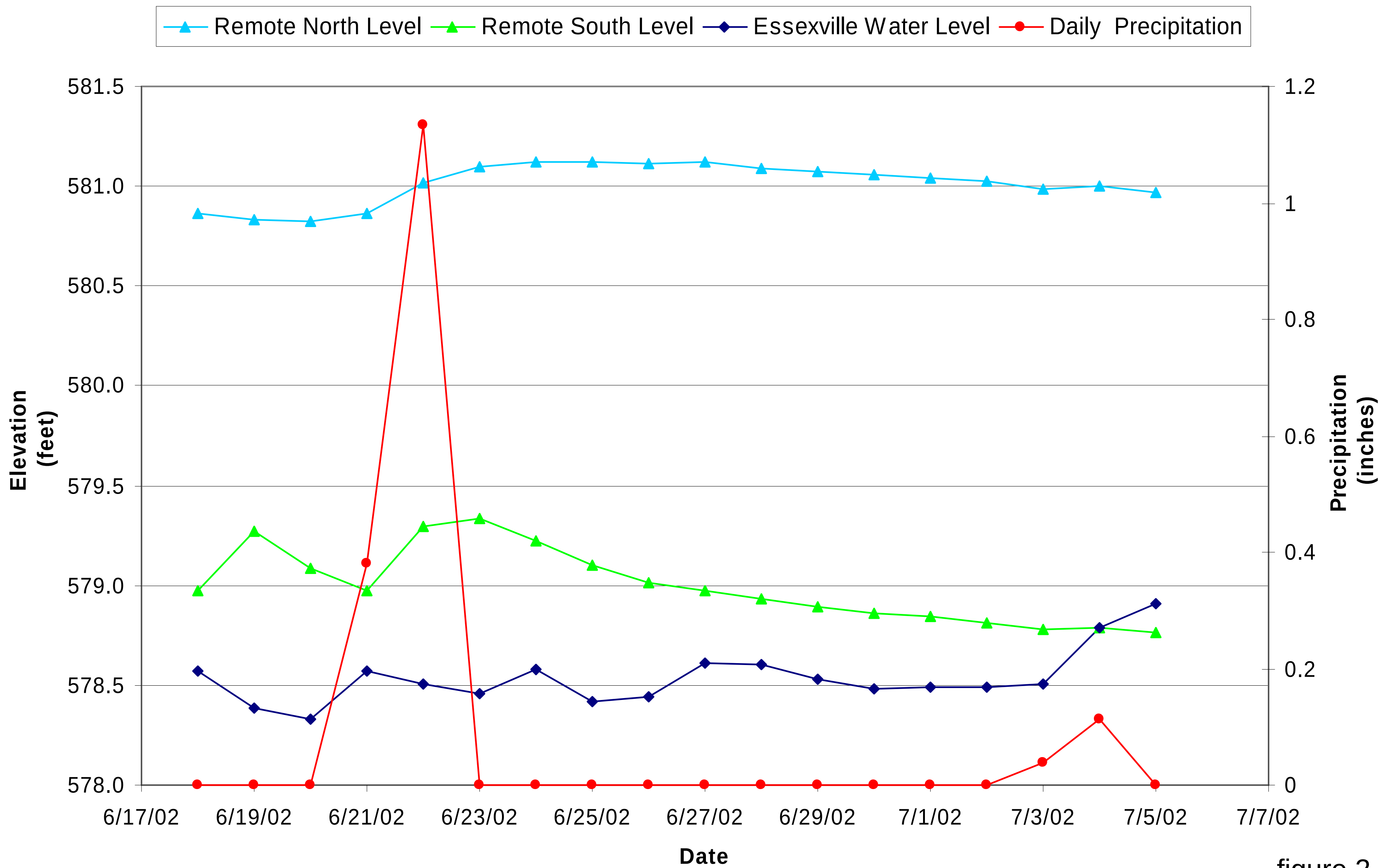


figure 2.4

MOST SIGNIFICANT 2002 PRECIPITATION EVENT AND WATER LEVELS
TOBICO MARSH
Saginaw River/Bay NRD Settlement

CRA

18204-03(013)GN-WA004 OCT 01/2004

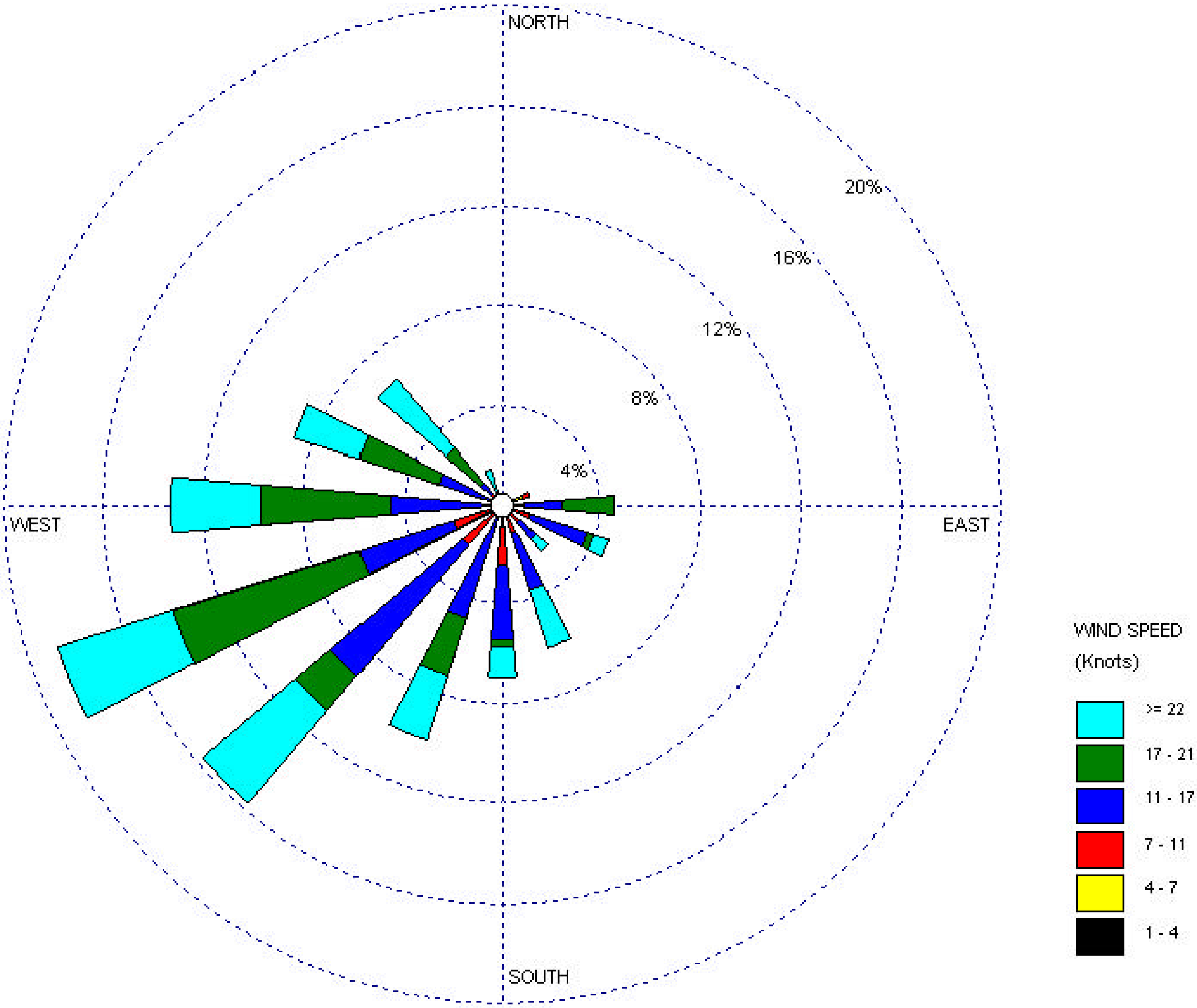


figure 2.5

WIND ROSE PLOT
TOBICO MARSH
Saginaw River/Bay NRD Settlement

18204-03(013)GN-WA005 OCT 01/2004

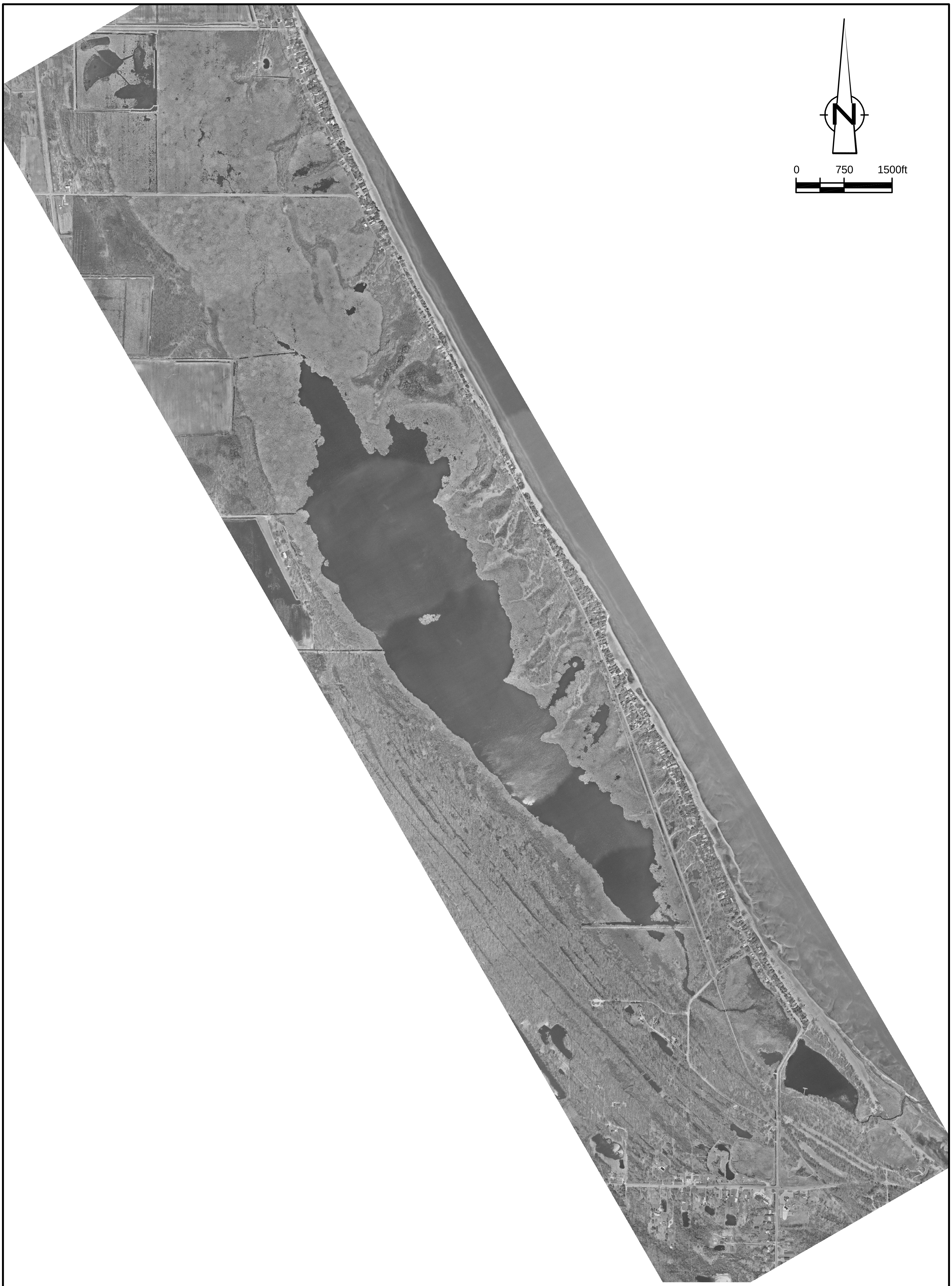
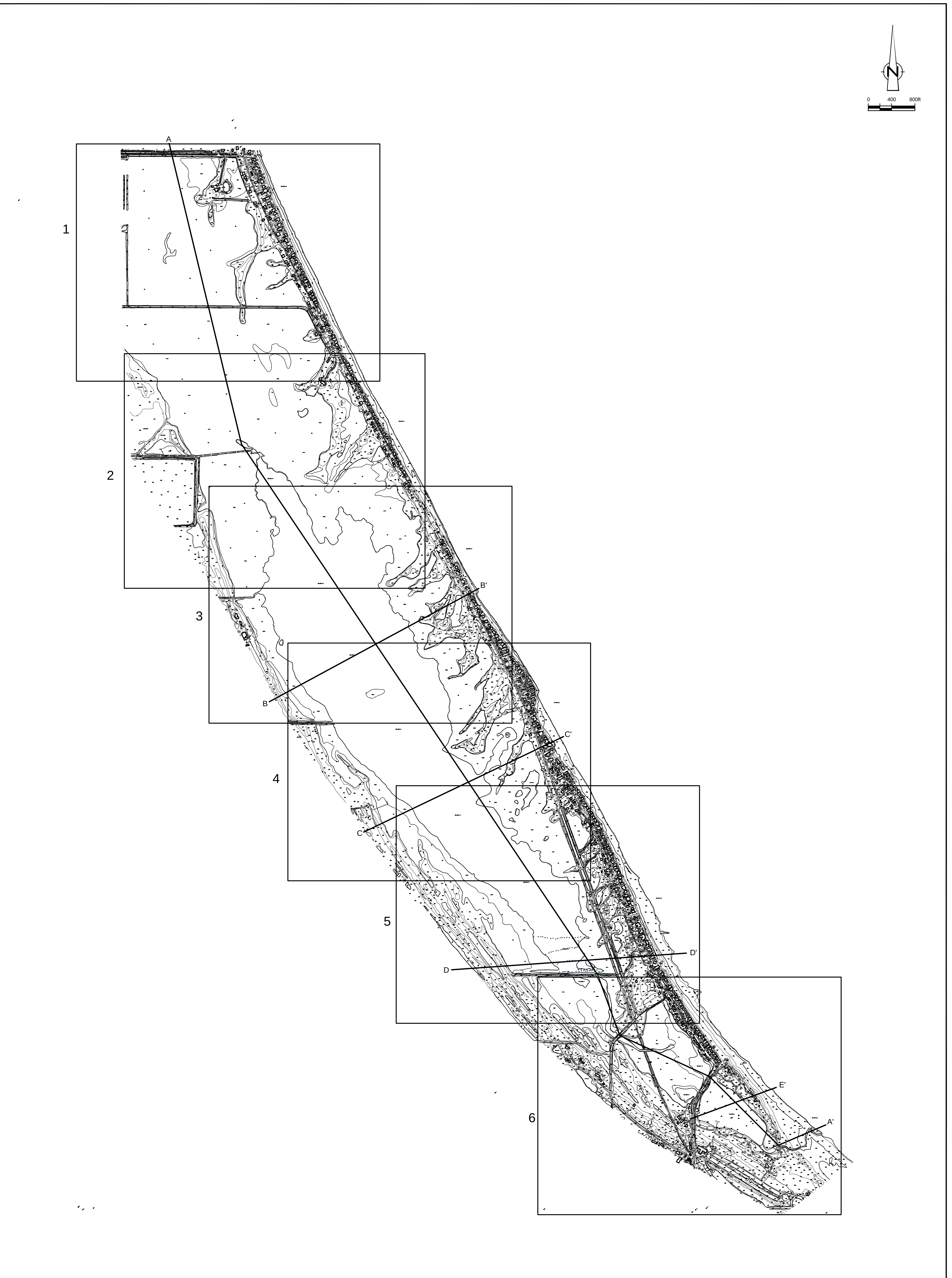


figure 2.6

AERIAL PHOTOGRAPH - MAY 4, 2002
TOBICO MARSH
Saginaw River/Bay NRD Settlement, Michigan

CRA

SOURCE: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002



Nº	Revision	Date	Initial	SCALE VERIFICATION	SAGINAW RIVER/BAY NRD SETTLEMENT	CONESTOGA-ROVERS & ASSOCIATES
				THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.	TOBICO MARSH 90% PLAN	Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002
				Approved	CROSS-SECTION AND ENLARGEMENT LOCATIONS	Project Manager: M. TOMKA; Reviewed By: C. AMEY; Date: OCTOBER 2004
						Scale: 1" = 800'; Project Nº: 18204-03; Report Nº: 013; Drawing Nº: 2.7

18204-03(013)GN-WA006 OCT 01/2004

№	Revision	Date	Initial

N

0 100 200ft

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

TOBICO MARSH AERIAL SECTION 1

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale:	Project №:	Report №:	Drawing №:
1" = 200'	18204-03	013	2.8

18204-03(013)GN-WA006 OCT 01/2004

№	Revision	Date	Initial

N

0 100 200ft

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

TOBICO MARSH AERIAL SECTION 2

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale:	Project №:	Report №:	Drawing №:
1" = 200'	18204-03	013	2.9

18204-03(013)GN-WA006 OCT 01/2004

Nº	Revision	Date	Initial

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SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

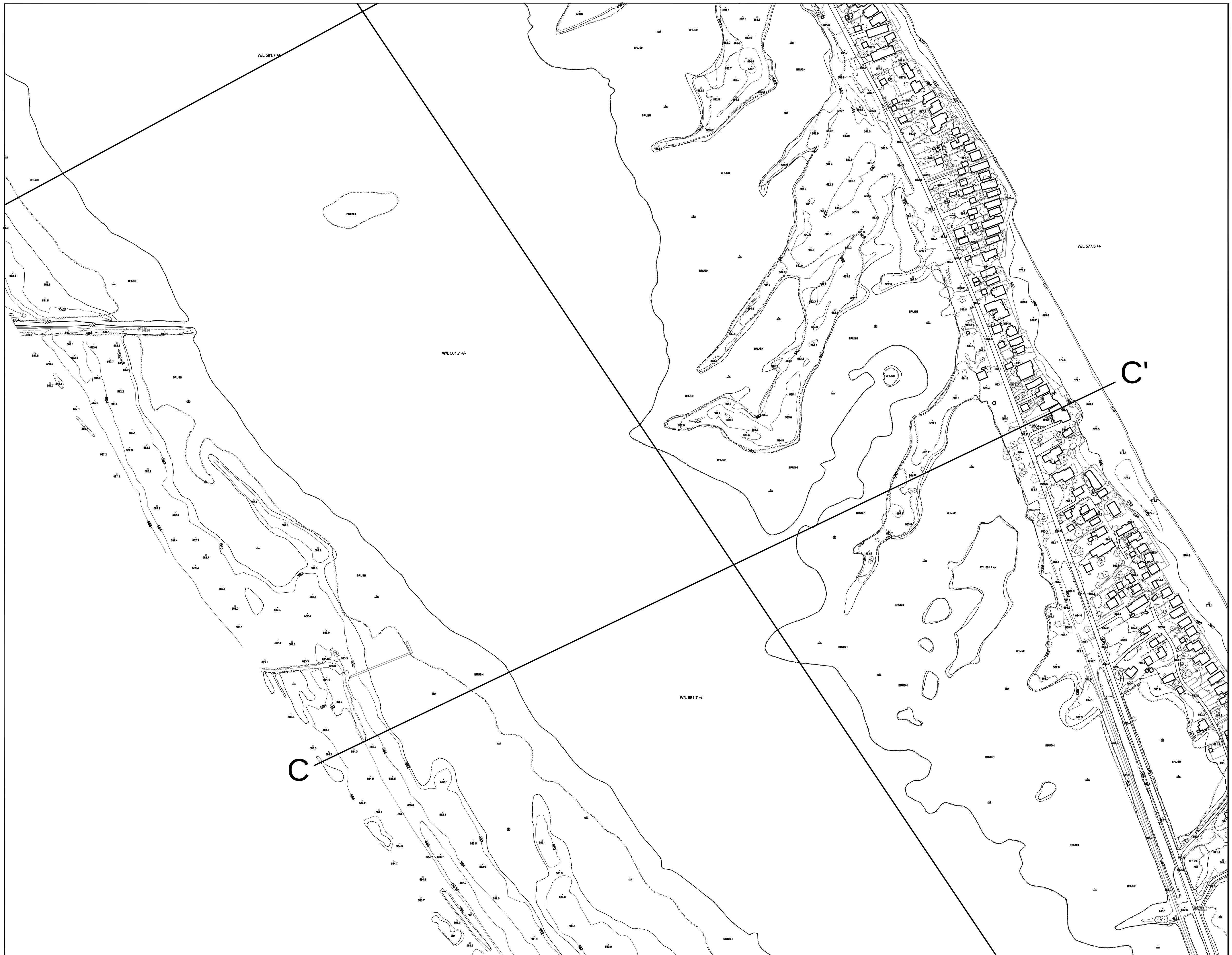
TOBICO MARSH AERIAL
SECTION 3

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 200'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: 2.10

18204-03(013)GN-WA006 OCT 01/2004



Nº	Revision	Date	Initial

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SCALE VERIFICATION

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Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

TOBICO MARSH AERIAL SECTION 4

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
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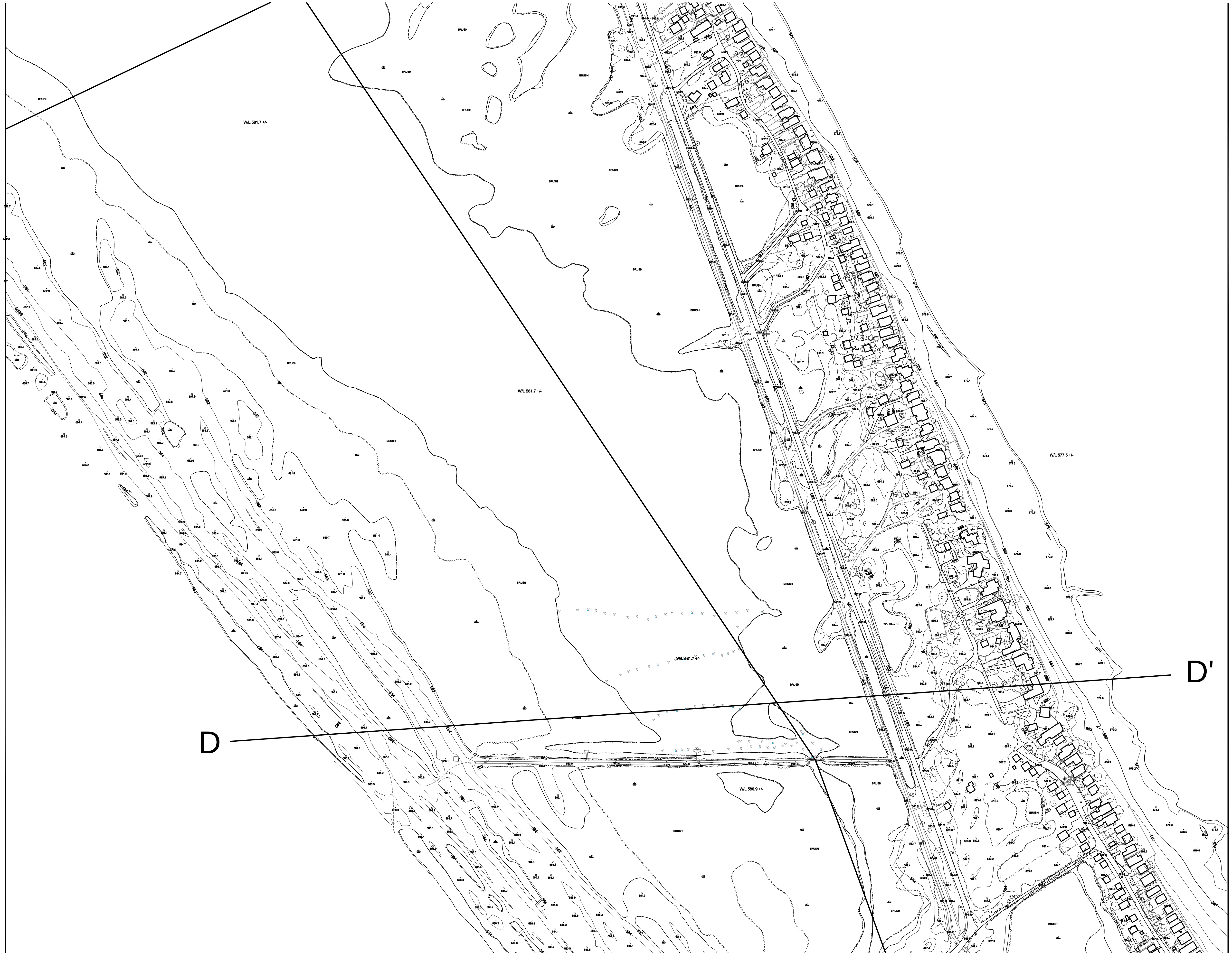
18204-03(013)GN-WA006 OCT 01/2004



Nº	Revision	Date	Initial

N

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SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

TOBICO MARSH AERIAL
SECTION 5

CRA CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
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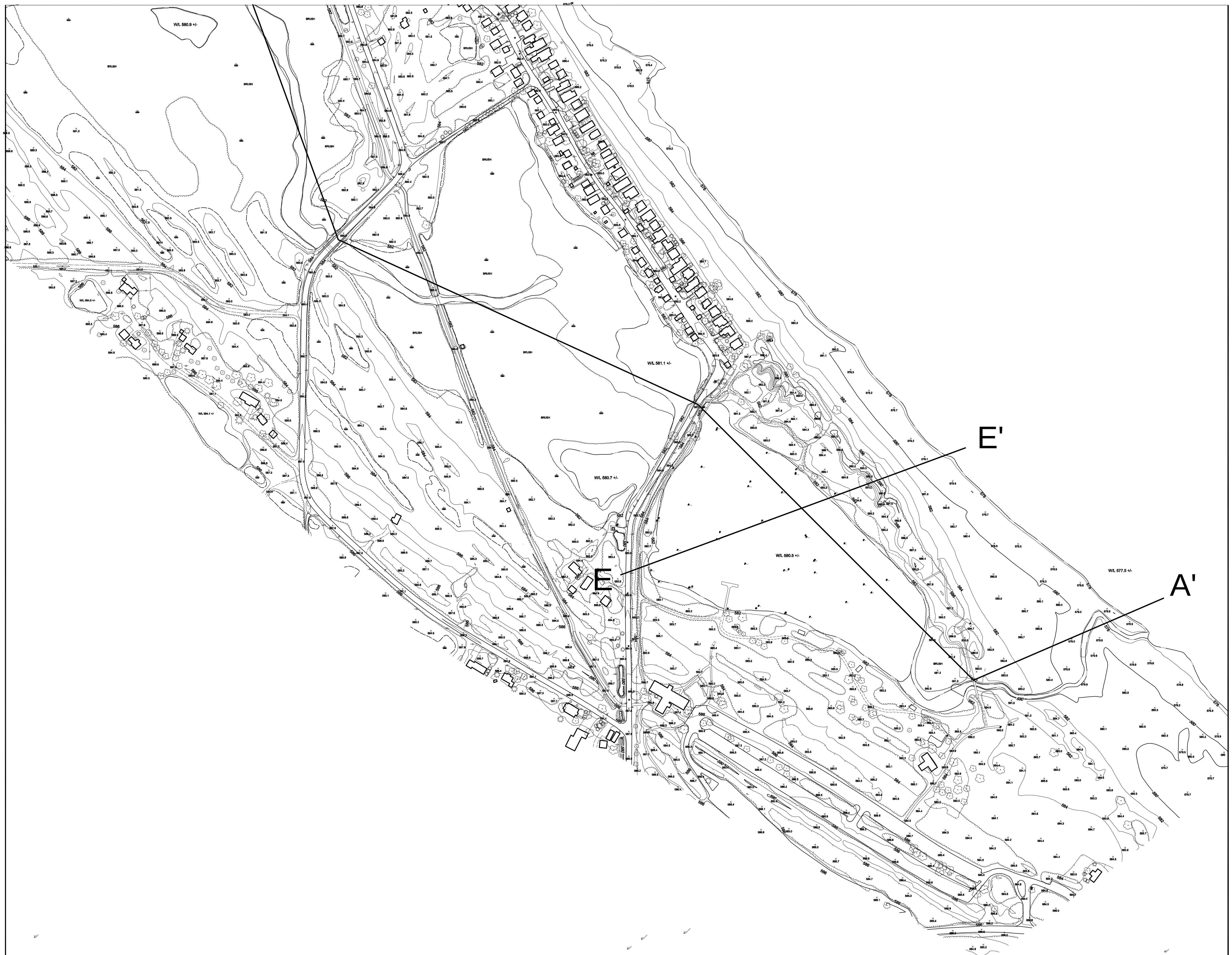
18204-03(013)GN-WA006 OCT 01/2004



Nº	Revision	Date	Initial

N

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SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

TOBICO MARSH AERIAL SECTION 6

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
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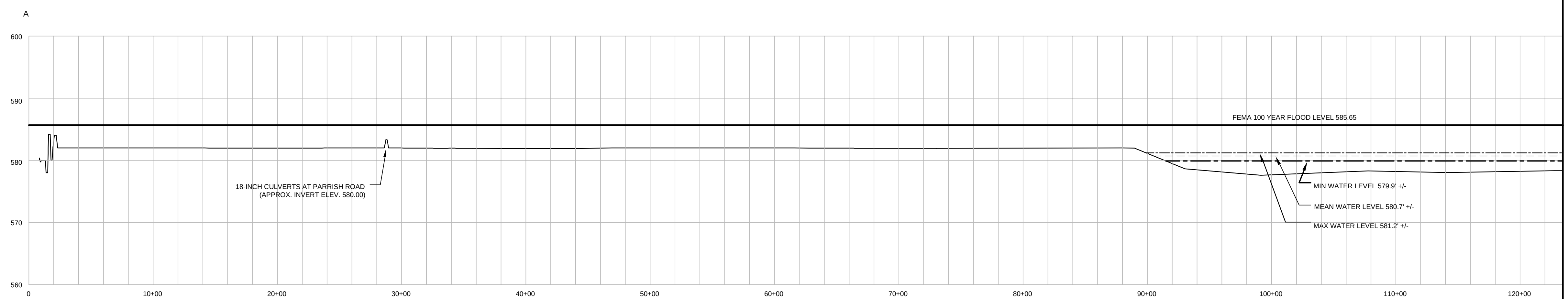
18204-03(013)GN-WA006 OCT 01/2004



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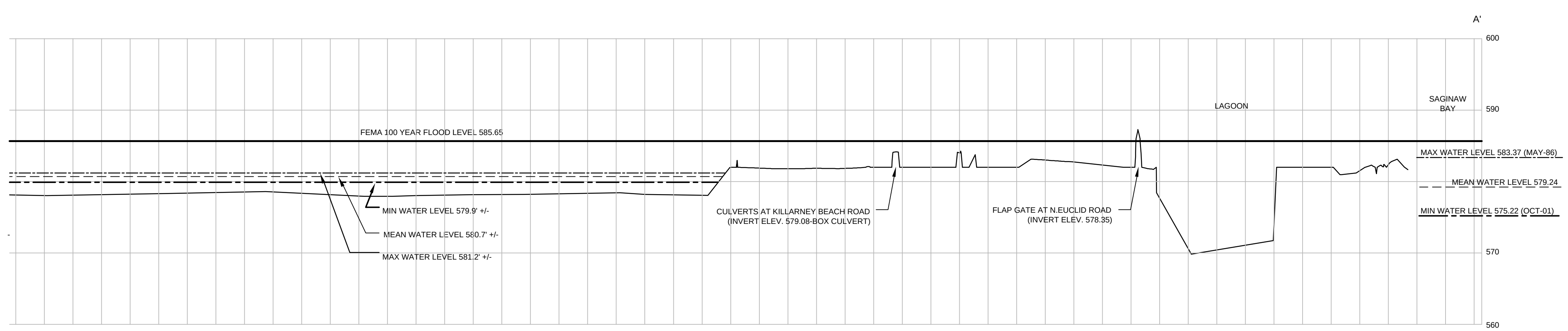

Nº	Revision	Date	Initial

NOTE: ALL ELEVATIONS IN IGLD'85 VERTICAL DATUM

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

CROSS SECTION A-A'

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager: M. TOMKA	Reviewed By: C. AMEY	Date: OCTOBER 2004	
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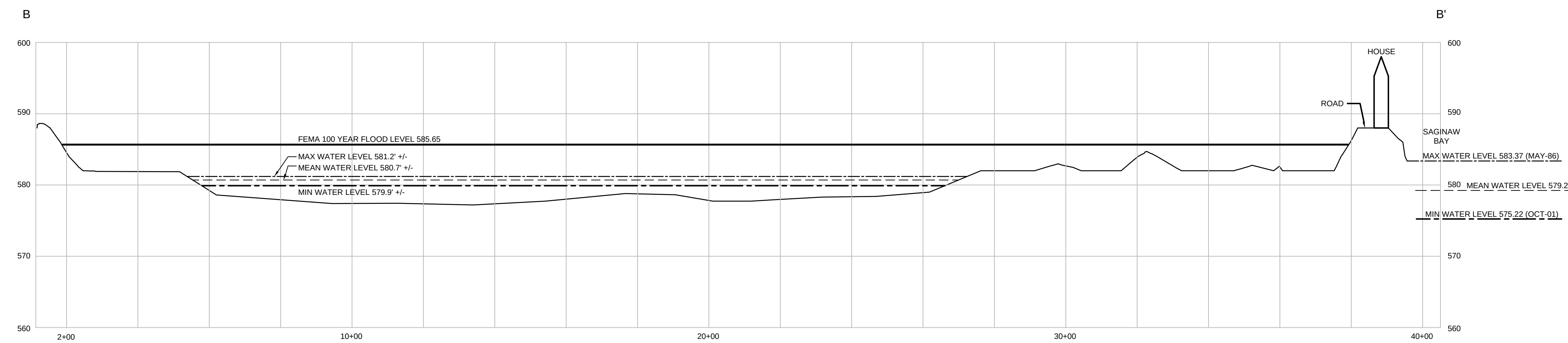
18204-03(013)GN-WA006 OCT 01/2004



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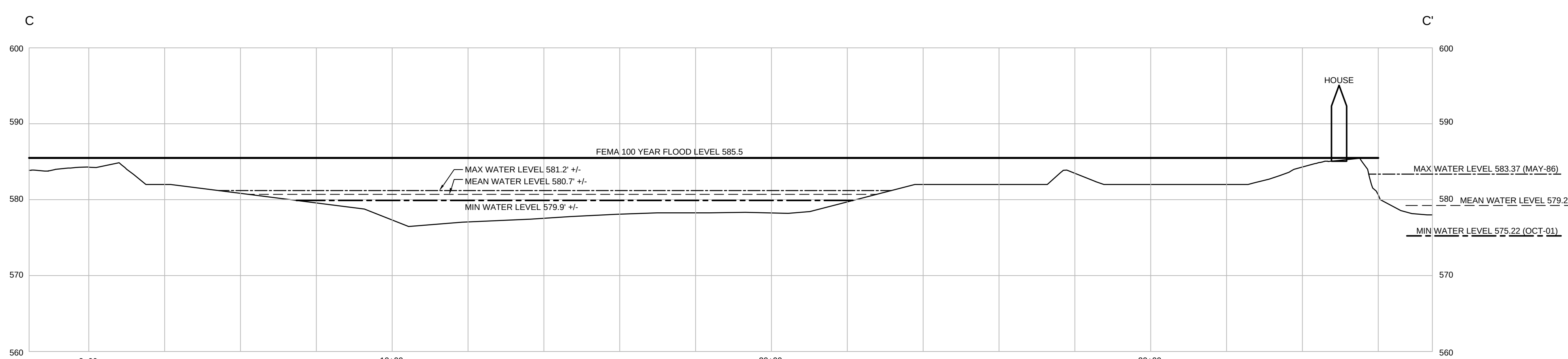


SCALES: 1"=200' HORIZONTAL
1"=10' VERTICAL

Nº	Revision	Date	Initial

NOTE: ALL ELEVATIONS IN IGLD'85 VERTICAL DATUM

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

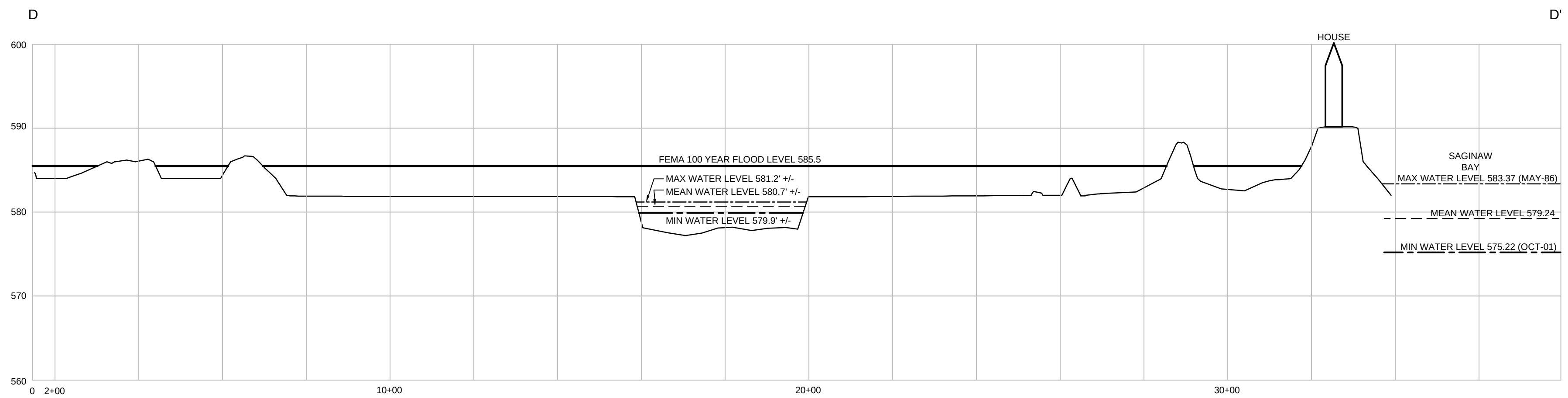
CROSS SECTIONS B-B' AND C-C'

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager: M. TOMKA	Reviewed By: C. AMEY	Date: OCTOBER 2004	
Scale: AS SHOWN	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: 2.15

18204-03(013)GN-WA006 OCT 01/2004



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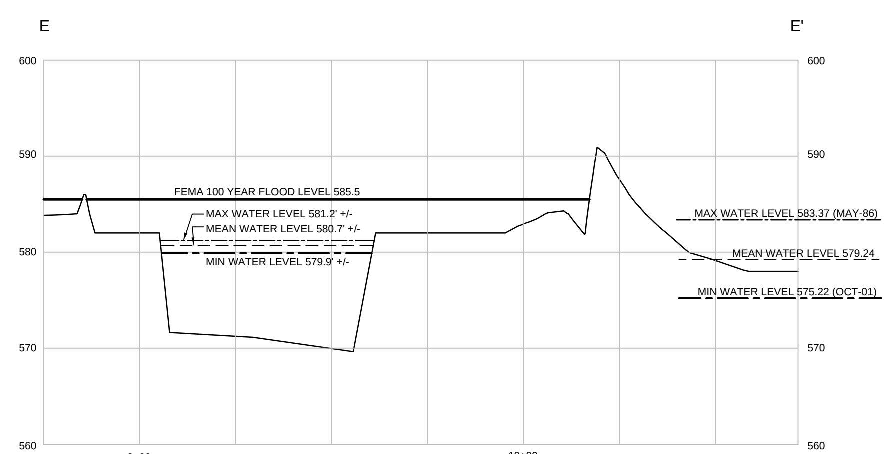


SCALES: 1"=200' HORIZONTAL
1"=10' VERTICAL

Nº	Revision	Date	Initial

NOTE: ALL ELEVATIONS IN IGLD'85 VERTICAL DATUM

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 90% PLAN

CROSS SECTIONS D-D' AND E-E'

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:

ADVANCED MAPPING TECHNOLOGIES, APRIL 5, 2002

Project Manager: M. TOMKA	Reviewed By: C. AMEY	Date: OCTOBER 2004	
Scale: AS SHOWN	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: 2.16

18204-03(013)GN-WA006 OCT 01/2004

PHOTO NO. 1 - OVERGROWN CULVERT

PHOTO NO. 2 - OVERGROWN CULVERT

PHOTO NO. 3 - OVERGROWN CULVERT

PHOTO NO. 4 - OVERGROWN CULVERT

figure 2.17

EXISTING CONDITIONS - WESTERN CULVERT ALONG PARISH ROAD
TOBICO MARSH
Saginaw River/Bay NRD Settlement

CRA

PHOTO NO. 1 - OVERGROWN CULVERT

PHOTO NO. 2 - OVERGROWN CULVERT

PHOTO NO. 3 - DETERIORATED AND PARTIALLY COLLAPSED CULVERT

PHOTO NO. 4 - OVERGROWN CULVERT

figure 2.18

EXISTING CONDITIONS - MIDDLE CULVERT ALONG PARISH ROAD
TOBICO MARSH
Saginaw River/Bay NRD Settlement

CRA

18204-03(013)GN-WA007 OCT 01/2004

PHOTO NO. 1 - OVERGROWN CULVERT

PHOTO NO. 2 - DETERIORATED CULVERT

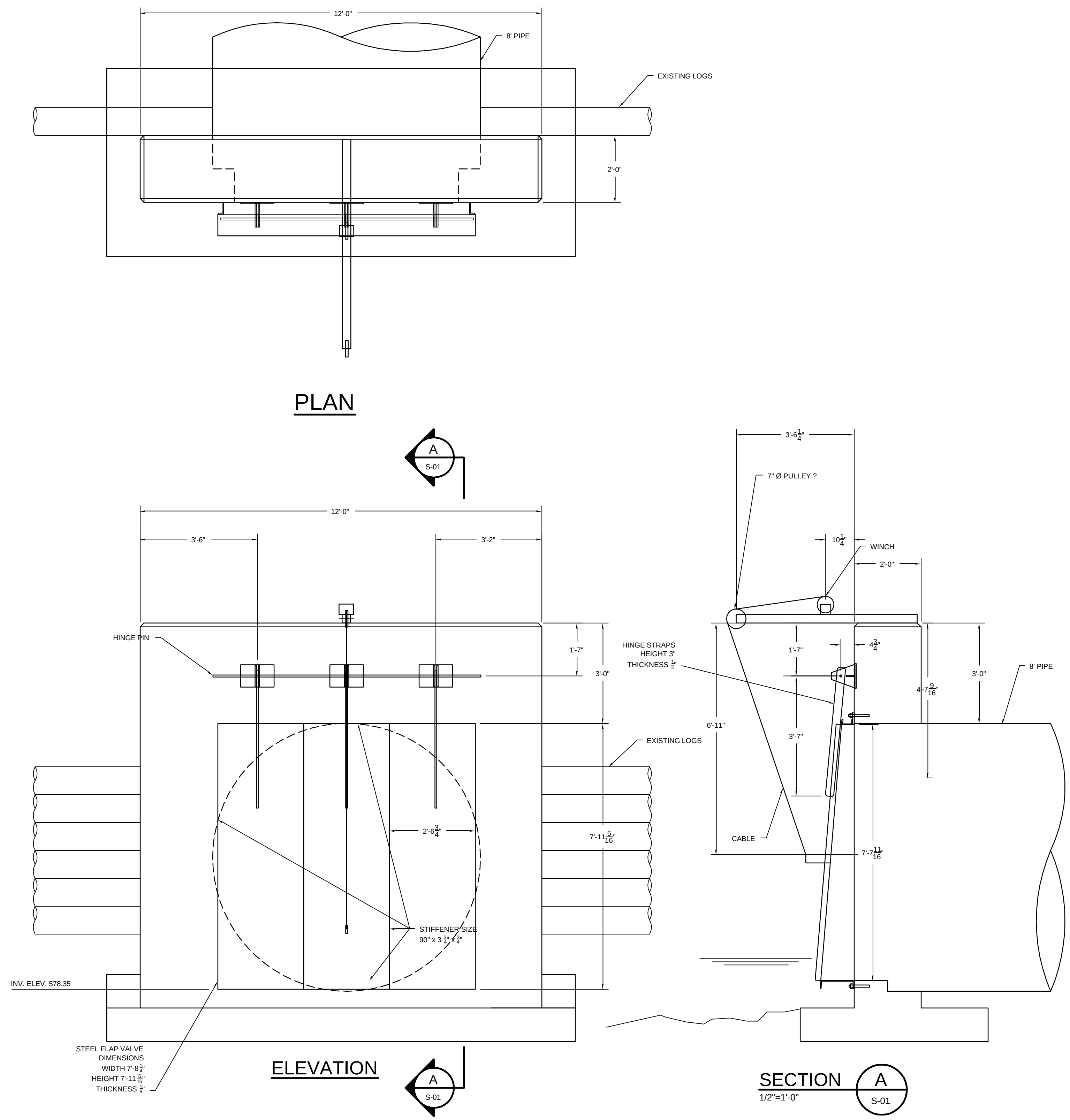
PHOTO NO. 3 - OVERGROWN CULVERT

PHOTO NO. 4 - OVERGROWN CULVERT

figure 2.19

EXISTING CONDITIONS - EASTERN CULVERT ALONG PARISH ROAD
TOBICO MARSH
Saginaw River/Bay NRD Settlement

CRA



STEEL FLAP-GATE EXISTING CONDITIONS

SCALE 1/2"=1'-0"

PRELIMINARY

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

SAGINAW RIVER/BAY NRD SETTLEMENT

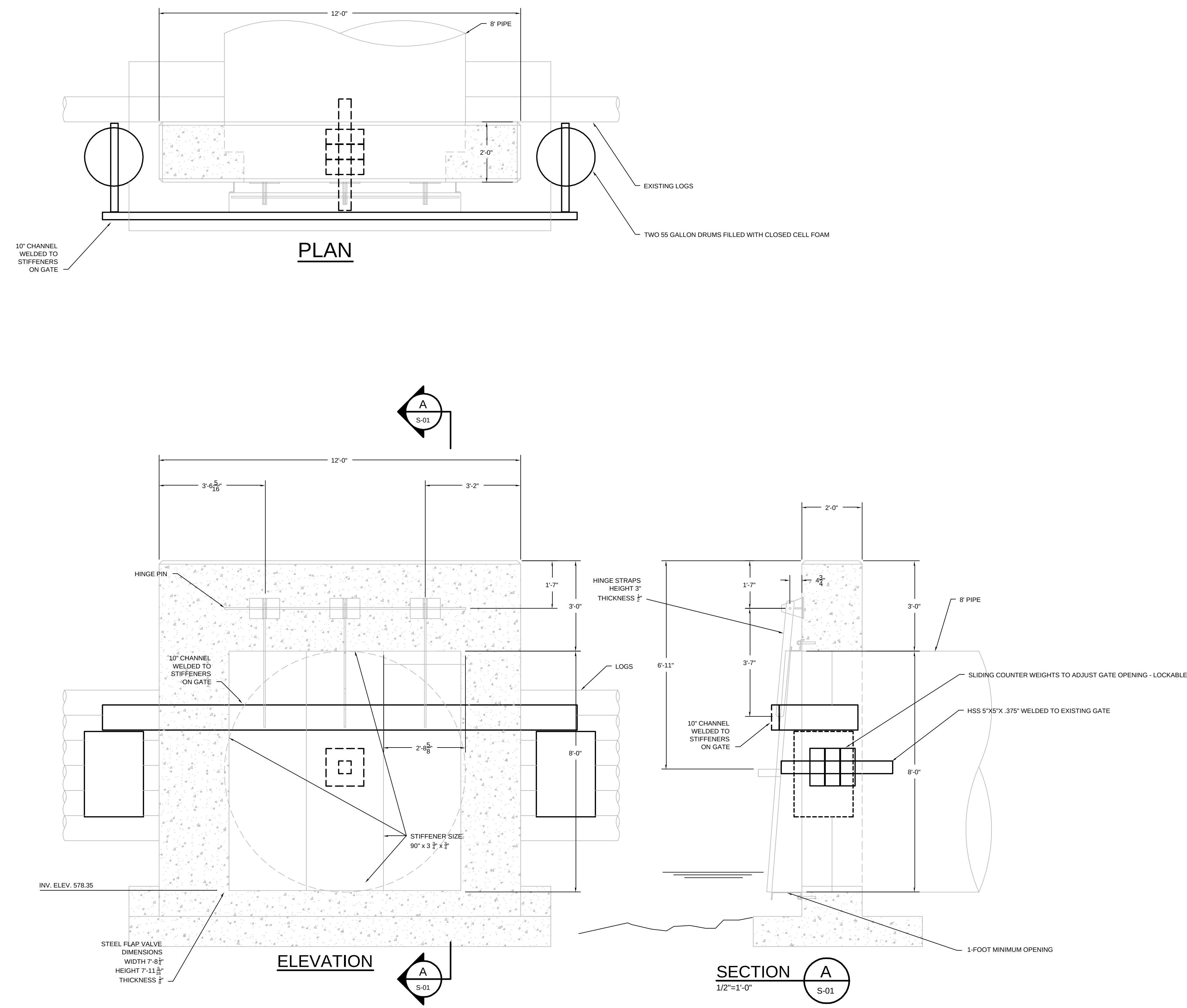
TOBICO MARSH 90% PLAN

FLAP-GATE
EXISTING CONDITIONS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: OCTOBER 2004
Project Manager: M. TOMKA	Reviewed By: C. AMEY	Designed By:	Drawn By:
Scale: AS SHOWN	Project No: 18204-03	Report No: 013	Drawing No: 2.20

18204-03(013)ST-WA001 OCT 01/2004



STEEL FLAP-GATE MODIFICATIONS

SCALE 1/2"=1'-0"

PRELIMINARY

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

SAGINAW RIVER/BAY NRD SETTLEMENT

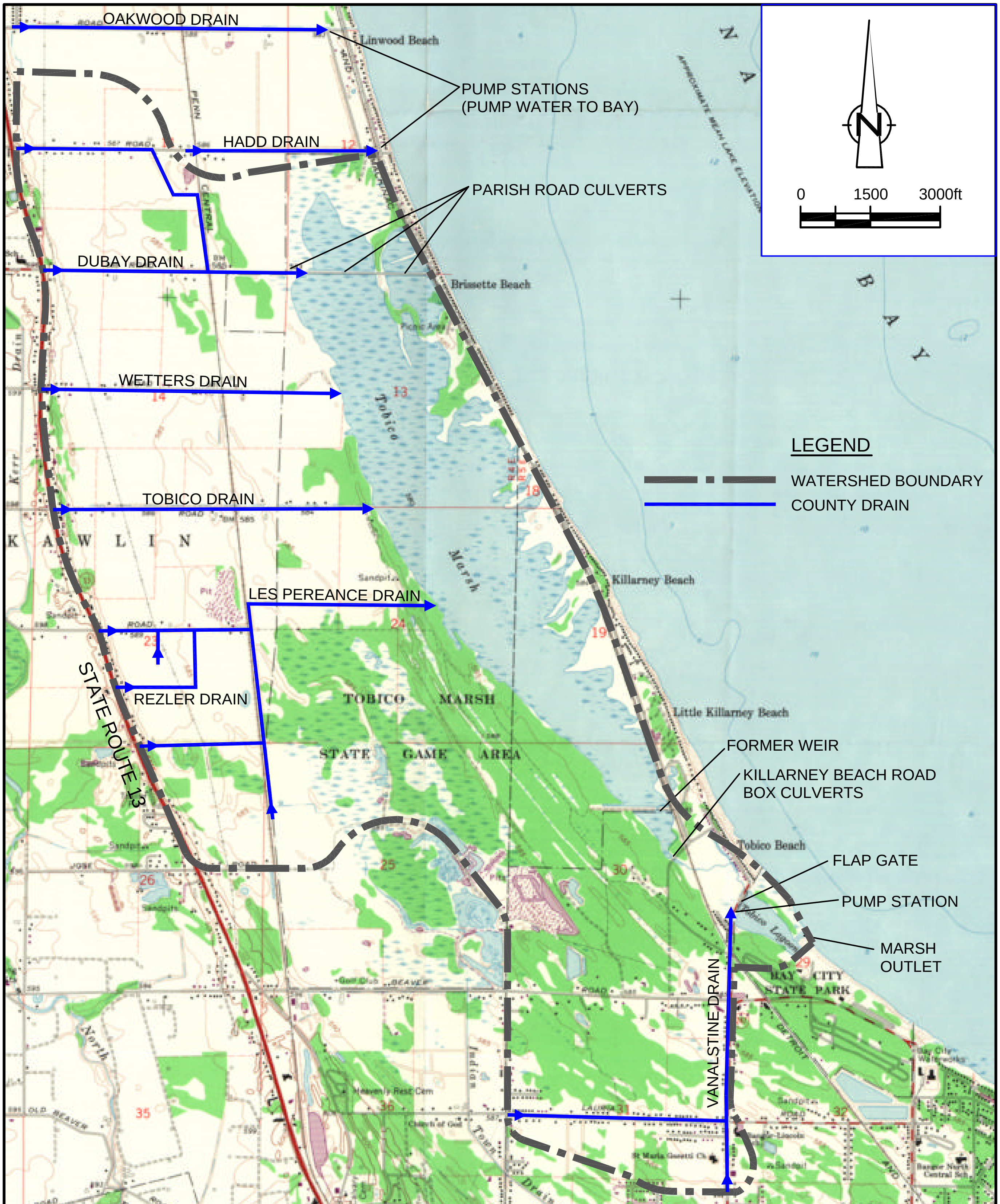
TOBICO MARSH 90% PLAN

PROPOSED FLAP-GATE MODIFICATIONS

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:			Date: OCTOBER 2004
Project Manager: M. TOMKA	Reviewed By: C. AMEY	Designed By:	Drawn By:
Scale: AS SHOWN	Project No: 18204-03	Report No: 013	Drawing No: 2.21

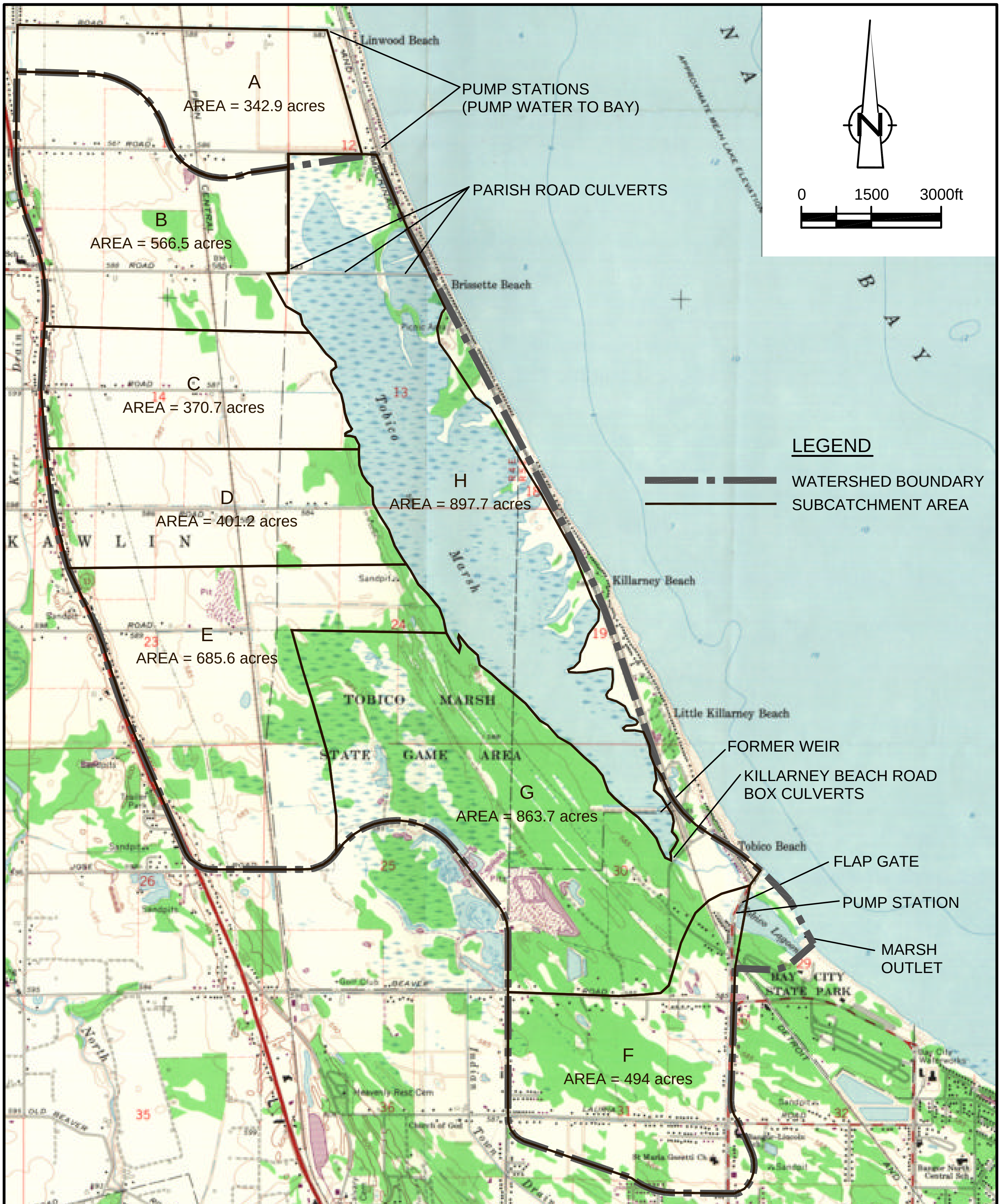
18204-03(013)ST-WA002 OCT 01/2004



SOURCE: USGS QUADRANGLE, KAWKAWLIN, MICH., 1967
BAY COUNTY DRAINAGE MAPS, 2002
(KAWKAWLIN AND BANGOR TOWNSHIPS)

figure 2.22

WATERSHED BOUNDARY
TOBICO MARSH
Saginaw River/Bay NRD Settlement



SOURCE: USGS QUADRANGLE, KAWKAWLIN, MICH., 1967
BAY COUNTY DRAINAGE MAPS, 2002
(KAWKAWLIN AND BANGOR TOWNSHIPS)

figure 2.23

SUBCATCHMENT AREAS
TOBICO MARSH
Saginaw River/Bay NRD Settlement

SOURCE: USGS QUADRANGLE, KAWKAWLIN, MICH., 1967

figure 5.1

PROJECT LOCATIONS - SITE PLAN
TOBICO MARSH
Saginaw River/Bay NRD Settlement

18204-03(013)GN-WA014 OCT 01/2004

TABLE 3.1

COST ESTIMATE OF ALTERNATIVES
TOBICO MARSH
SAGINAW BAY, MICHIGAN

	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 4*
Total Capital Costs	$0.00	$6,813.25	$21,186.50	$49,583.00
Total Annual Operation and Maintenance Costs	$0.00	$1,890.00	$2,720.00	$4,130.00
Total Present Worth Cost (3.5% Discount Rate - Infinite Years of Operation)	$0.00	$53,997.30	$77,710.40	$117,994.10
TOTAL PRESENT WORTH COST FOR ALTERNATIVE	$0.00	$60,810.55	$98,896.90	$167,577.10

TABLE 3.2

DETAILED COST ESTIMATE
TOBICO MARSH ALTERNATIVES
SAGINAW BAY, MICHIGAN

Item	*Quantity*	*Unit*	*Unit Rate*	*Total Costs*
ALTERNATIVE 1				
No Action				$ -

TABLE 3.2

DETAILED COST ESTIMATE
TOBICO MARSH ALTERNATIVES
SAGINAW BAY, MICHIGAN

Item	*Quantity*	*Unit*	*Unit Rate*	*Total Costs*
ALTERNATIVE 2				
CAPITAL COSTS				
A. Parish Rd Culvert Upgrades and Cleanout				
A.1. Project Management				
Project Manager	5	hours	$ 104.65	$ 523.25
A.2. Riprap Placement				
Supply of Rip-Rap Material	1	load	$ 500.00	$ 500.00
Mob. / Demob.	--	L.S.	--	$ 500.00
Backhoe and Operator	1	day	$ 1,200.00	$ 1,200.00
Project Engineer / Oversight	10	hour	$ 77.00	$ 770.00
Disbursements	--	L.S.	--	$ 500.00
A.3. Initial Clean-out of Culverts				
Technician	40	hour	$ 58.00	$ 2,320.00
Disbursements	--	L.S.	--	$ 500.00
TOTAL CAPITAL COSTS				**$ 6,813.25**
OPERATION AND MAINTENANCE COSTS				
A.4. Annual Remote Monitoring Equipment	12	month	$ 40.00	$ 480.00
A.5. Annual Clean-out of Culverts				
Technician	20	hour	$ 58.00	$ 1,160.00
Disbursements	--	L.S.	--	$ 250.00
Total Annual Operation and Maintenance Costs				$ 1,890.00
TOTAL PRESENT WORTH COST FOR O&M (3.5% Discount Rate - Infinite Years of Operation)				**$ 53,997.30**
TOTAL PRESENT WORTH COST FOR ALTERNATIVE				**$ 60,810.55**

TABLE 3.2

DETAILED COST ESTIMATE
TOBICO MARSH ALTERNATIVES
SAGINAW BAY, MICHIGAN

Item	*Quantity*	*Unit*	*Unit Rate*	*Total Costs*
ALTERNATIVE 3				
CAPITAL COSTS				
A. Parish Rd Culvert Upgrades and Cleanout				
A.1. Project Management				
Project Manager	5	hours	$ 104.65	$ 523.25
A.2. Riprap Placement				
Supply of Rip-Rap Material	1	load	$ 500.00	$ 500.00
Mob. / Demob.	--	L.S.	--	$ 500.00
Backhoe and Operator	1	day	$ 1,200.00	$ 1,200.00
Project Engineer / Oversight	10	hour	$ 77.00	$ 770.00
Disbursements	--	L.S.	--	$ 500.00
A.3. Initial Clean-out of Culverts				
Technician	40	hour	$ 58.00	$ 2,320.00
Disbursements	--	L.S.	--	$ 500.00
Total Capital Costs for Parish Rd Culvert Upgrades and Cleanout				$ 6,813.25
B. Cleanout & Flap-Gate Upgrades				
B.1. Project Management				
Project Manager	5	hours	$ 104.65	$ 523.25
B.2. Upgrade of Existing Flap-Gate				
Design	40	hr	$ 100.00	$ 4,000.00
Construction Materials	--	L.S.	--	$ 2,500.00
Laborer	50	hour	$ 58.00	$ 500.00
Miscellaneous Construction Equipment	--	L.S.	--	$ 1,500.00
Construction Oversight	50	hour	$ 77.00	$ 3,850.00
Disbursements	--	L.S.	--	$ 1,500.00
Total Capital Costs for Cleanout & Flap-Gate Upgrades				$ 14,373.25
TOTAL CAPITAL COSTS				**$ 21,186.50**
OPERATION AND MAINTENANCE COSTS				
A. Parish Rd Culvert Upgrades and Cleanout				
A.4. Annual Remote Monitoring Equipment	12	month	$ 40.00	$ 480.00
A.5. Annual Clean-out of Parish Rd Culverts				
Technician	20	hour	$ 58.00	$ 1,160.00
Disbursements	--	L.S.	--	$ 250.00
B. Cleanout & Flap-Gate Upgrades				
B.3. Annual Maintenance of Flap-Gate				
Technician	10	hour	$ 58.00	$ 580.00
Disbursements - Additional Materials as needed	--	L.S.	--	$ 250.00
Total Annual Operation and Maintenance Costs				$ 2,720.00
TOTAL PRESENT WORTH COST FOR O&M (3.5% Discount Rate - Infinite Years of Operation)				**$ 77,710.40**
TOTAL PRESENT WORTH COST FOR ALTERNATIVE				**$ 98,896.90**

TABLE 3.2

DETAILED COST ESTIMATE
TOBICO MARSH ALTERNATIVES
SAGINAW BAY, MICHIGAN

Item	*Quantity*	*Unit*	*Unit Rate*	*Total Costs*
ALTERNATIVE 4				
CAPITAL COSTS				
A. Parish Rd Culvert Upgrades and Cleanout				
A.1. Project Management				
Project Manager	5	hours	$ 104.65	$ 523.25
A.2. Riprap Placement				
Supply of Rip-Rap Material	1	load	$ 500.00	$ 500.00
Mob. / Demob.	--	L.S.	--	$ 500.00
Backhoe and Operator	1	day	$ 1,200.00	$ 1,200.00
Project Engineer / Oversight	10	hour	$ 77.00	$ 770.00
Disbursements	--	L.S.	--	$ 500.00
A.3. Initial Clean-out of Culverts				
Technician	40	hour	$ 58.00	$ 2,320.00
Disbursements	--	L.S.	--	$ 500.00
Total Capital Costs for Parish Rd Culvert Upgrades and Cleanout				$ 6,813.25
B. Cleanout & Flap-Gate Upgrades				
B.1. Project Management				
Project Manager	5	hours	$ 104.65	$ 523.25
B.2. Upgrade of Existing Flap-Gate				
Design	40	hr	$ 100.00	$ 4,000.00
Construction Materials	--	L.S.	--	$ 2,500.00
Laborer	50	hour	$ 58.00	$ 500.00
Miscellaneous Construction Equipment	--	L.S.	--	$ 1,500.00
Construction Oversight	50	hour	$ 77.00	$ 3,850.00
Disbursements	--	L.S.	--	$ 1,500.00
Total Capital Costs for Cleanout & Flap-Gate Upgrades				$ 14,373.25
C. Re-Routing of Hadd Drain				
C.1. Project Management				
Project Manager	10	hours	$ 104.65	$ 1,046.50
C.2. Re-routing of Hadd Drain and Construction of Additional Culverts				
Design	40	hr	$ 100.00	$ 4,000.00
Excavation of Material Under Road Bedding	120	yd^3	$ 10.00	$ 1,200.00
18-inch, 40-foot Corrugated Steel Culvert Pipe	4	each	$ 2,000.00	$ 8,000.00
Backfill and Compaction	120	yd^3	$ 25.00	$ 3,000.00
Asphalt Restoration	480	ft^2	$ 10.00	$ 4,800.00
Placement of Rip-Rap	2	loads	$ 500.00	$ 1,000.00
Construction Oversight	50	hour	$ 77.00	$ 3,850.00
Disbursements	--	L.S.	--	$ 1,500.00
Total Capital Costs of Re-Routing of Hadd Drain				$ 28,396.50
TOTAL CAPITAL COSTS				**$ 49,583.00**

TABLE 3.2

DETAILED COST ESTIMATE
TOBICO MARSH ALTERNATIVES
SAGINAW BAY, MICHIGAN

Item	*Quantity*	*Unit*	*Unit Rate*	*Total Costs*
ALTERNATIVE 4 CONTINUED				
OPERATION AND MAINTENANCE COSTS				
A. Parish Rd Culvert Upgrades and Cleanout				
A.4. Annual Remote Monitoring Equipment	12	month	$ 40.00	$ 480.00
A.5. Annual Clean-out of Parish Rd Culverts				
Technician	20	hour	$ 58.00	$ 1,160.00
Disbursements	--	L.S.	--	$ 250.00
B. Cleanout & Flap-Gate Upgrades				
B.3. Annual Maintenance of Flap-Gate				
Technician	10	hour	$ 58.00	$ 580.00
Disbursements - Additional Materials as needed	--	L.S.	--	$ 250.00
C. Re-Routing of Hadd Drain				
C.3. Annual Clean-out of Culverts for Hadd Drain Re-Routing				
Technician	20	hour	$ 58.00	$ 1,160.00
Disbursements	--	L.S.	--	$ 250.00
Total Annual Operation and Maintenance Costs				$ 4,130.00
TOTAL PRESENT WORTH COST FOR O&M (3.5% Discount Rate - Infinite Years of Operation)				**$ 117,994.10**
TOTAL PRESENT WORTH COST FOR ALTERNATIVE				**$ 167,577.10**

APPENDIX A

JANUARY 30, 2002 SCOPING MEETING MINUTES

Tobico Marsh Restoration Public Comments

Notes from Public Scoping Meeting, January 30, 2002

[*Comments were compiled by Lisa Williams, U.S. Fish and Wildlife Service, on January 31, 2002, based on her written notes from the meeting. Comments recorded in this section are approximate quotes or paraphrases of statements made by private citizens at the meeting and do not reflect conclusions of the Tobico Marsh Restoration planning group.*]

Historically, water levels have been much higher than they are now. An engineering study should be done to determine the effects of rain and wind events during high water periods.

Several people expressed concern about the Hartley & Hartley Landfill:

-site will be delisted from Superfund this year, so time to do something is now
-need to determine if site is leaking contaminants into the marsh
-people in the audience blame human and pet cancers, human cranial nerve disorders and chemical sensitivity on the landfill
-need to determine if changing water fluctuations would cause more contamination in the marsh and bay
-check MDEQ report, August 1993, available from Mike Jury
-sediment lifted from the bottom (unspecified location) releases an oily sheen
-contamination should be fixed before money is spend on restoration
-Can this money be used to fix the landfill or to leverage money to fix the landfill?

Tobico Lagoon had two openings in the 1960's.

The opening now is smaller and farther south than the opening shown in an aerial photograph from the July 1974 cover of Lakeland Boating magazine [Mike Bristow].

The existing opening was changed in 1993 by the park manager.

At a different public meeting several years ago, several people remember a farmer from near Linwood or Pinconning saying that the marsh once had an opening to the bay at its north end. One commenter remembered him saying that the farmer owned the land that the opening had been on and might donate it under the right conditions. After the meeting, one person described this opening as being a ditch with a culvert under a road, like the one south of Singing Bridge. He had gone smelting there as a kid and even gotten a rainbow trout one time.

Property in Little Killarney beach extends from the bay into the marsh. Property owners believe they own land which is inundated in the marsh and that any rise in water levels will take additional property.

Fertilizer in runoff may affect water quality in Tobico Marsh.

A larger opening to the bay could result in increased boat traffic in the lagoon and this may affect "privately owned parts of the marsh" and bring in more trash and pollution from boat operation.

Roads have been flooded sometimes.

The flap gate isn't big enough. More holes should be made in the dike by the flap gate. The flap gate should be removed. The flap gate should be replaced with a spillway, but that spillway should allow fish passage. Consider two spillways with the same sill height, but facing opposite directions. Look at the RMG report for a floating spillway designed to stop inflow during high lake levels. The flap gate sits two feet higher than the old one.

The pumping station at Tobico Road continues to pump ditch water into the marsh which then backs up from the culvert. This water should be pumped to the other (downstream) side of the road and culverts.

For the RMG report, the investigators were not allowed into the back part of the marsh.
The railroad is gone, but they used to complain about high water in the marsh eroding the foundation of the tracks.

The water level was low in the 1930's. Did the marsh dry up then?

Cattails are now choking the marsh and something should be done about them.

Some locals are on extended winter vacations and may not be able to reply by the March 6 deadline for comments. [The Service agreed, at the meeting, to extend the deadline until April 6, 2002.]

Consider future meetings on the weekend since some people are only here on the weekends, although other commenters disagreed that many people would come on a weekend.

Some people pump water out of the marsh to mow their lawns. They might be getting contaminants that way.

The wildlife and plants must be protected too, not just private property. People who don't live here use and enjoy nature here.

One person, 42 years old, has hunted here his whole life and not seen anything wrong with any fish or wildlife or himself.

Get the flow going so the marsh is not stagnant anymore. Make it better for bass and pike.

The existing footbridge that crosses the outlet might need to be changed if the opening is enlarged and if continued dredging is anticipated.

Walls extending into the bay may be needed to keep the opening open.

The author of one of the chapters in the book Tobico Marsh offered historical maps of the hunt club to Mike Tomka. Mike has the gentleman's business card.

Written Comments following Public Scoping Meeting, January 30, 2002

1) (name withheld) [Written comments submitted at meeting.]

Cattails need to be reduced. More open water needs to be available. Cattails choke out aquatic weeds.
Pumping station on north end of marsh must be eliminated so water flows thru marsh. Boutel and Parish.
Opening to Bay at State Park lagoon must be opened and kept open so fish can migrate into the marsh from the bay.
The wetland southeast end may have a negative impact
dead weed decay rob lagoon of oxygen.

2) Mike Bristow [Written comments submitted at meeting.]

Submitted copies of documents on Hartley & Hartley landfill from MDEQ files.

3) Mr. and Mrs. William H. Quinn, 108 Killarney Beach, Bay City, Michigan 48706 (989-684-2230) [Written comments received at ELFO on 3-25-02.]

Regarding the proposed restoration of Tobico Marsh, we are in favor of it. We are concerned about flooding. We have been out here since 1956. In the 70's when the bay was high we had a foot of water in our yard and garage.
The Army Corp built the dyke and flood gate. Flood gate was some good when it worked and wasn't plugged with junk.
I would like water running through – help clean it out and improve fishing.
Thank you for letting me putting our 2 cents in.

4) Ethel M. Trombley, 124 Little Killarney Beach, Bay City, Michigan 48706 (989-684-9013) [Written comments received at ELFO on 3-28-02.]

My name is Ethel M. Trombley. I live on Little Killarney Beach - my land is part of the Tobico Marsh. I am concerned about the control of the water level. Who controls it? I would not want it opened to the public for boating or fishing or sight seeing as this is part of my back yard.

I am very concerned about disturbing the Hartley landfill and all its chemicals. This could get into my back yard or the Bay itself. I'm in Fl. and will be home the 12th of May.

5) William S. Repp, 120 Little Killarney Beach, Bay City, Michigan 48706 (989-667-0908) [Written comments received at ELFO on 3-29-02.]

Regarding the proposed restoration of Tobico Marsh, I have the following concerns:

1) Who will have specific responsibility for dam/water control in event of emergencies?

2) Who will be responsible for maintaining structures used to control water?

3) We own a portion of the marsh. Do we have property rights of control? Access?

4) If the "Service" wishes to "restore" (change) the marsh, are they willing to purchase our land now in the marsh?

5) How can you dredge or otherwise modify our property without our approval?

6) Kiki Vanden Brooks, 122 Little Killarney Beach, Bay City, Michigan 48706-1114 (989-684-9525) [Written comments received at ELFO on 4-8-02.]

Regarding the proposed restoration of Tobico Marsh, I have the following concerns:

Who will control the water levels? What method(s) of control will be employed? Will measures be taken to ensure flooding of our back yards / roads / homes does not occur? Will preventiaon of erosion of our back yards be a consideration?

Will chemical leachate from the Hartley Landfill (which contains thorium & uranium & abuts the Marsh) be at all disturbed by dredging or high water? Is there even the slightest chance it will become airborne or seep into the water?

Will runoff from farmers' fields - or homeowners' lawns (fertilizers, etc.) - be more likely to end up in the Marsh that constitutes our back yards, or in the Saginaw Bay?

Will access to the Marsh be restricted? Little Killarney landowners own part of the Marsh, i.e. it constitutes part of our back yards. Unless you live there, you cannot tell where the public land ends & the private begins. We would not like people boating, fishing , or hunting in our back yard.

I find the word "adequate" in the goal statement troublesome. It is a subjective word, which could be interpreted to mean <u>minimal</u>, thus implying minimal "flood protection to riparian residences". I am sure you can understand how discomfiting that thought is to those of us who reside there. Hopefully a more encouraging qualifier can be substituted.

Saginaw River/Bay NRDA Meeting Minutes

Tobico Marsh Restoration Work Group
July 11, 2001
MDNR, Bay City, Michigan

Participants

- Jim Baker, Michigan Department of Natural Resources (MDNR), Fisheries Division
- Pieter Booth, Exponent
- Michael Evanoff, MDNR, Parks Division
- Donald Knorr, CRA
- Joe Medved, General Motors
- Doug Reeves, MDNR, Wildlife Division
- Michael Tomka, CRA
- Lisa Williams, U.S. Fish and Wildlife Service (U.S. FWS).

The meeting agenda and signup sheet are provided as Attachments 1 and 2.

Items Discussed and Results

1. Consent Judgment Requirements and Implementation Process

- Participants discussed the following Consent Judgment language referring to the Tobico Marsh restoration project: Paragraph 7.8: "***Resource Restoration – Fisheries Habitat Improvement.*** *To enhance fishery resources of Saginaw Bay and Tobico Marsh (part of the Bay City State*

Recreation Area), Defendants shall submit within thirty (30) days after the third (3rd) anniversary of the entry of this Consent Judgment to the Trustees for approval an initial plan to restore and thereafter restore, in accordance with the approved final plan, fisheries habitat in the Tobico Marsh and to increase the recreational fishing opportunities provided by the Tobico Marsh. Defendants shall not be obligated to expend more than Five Hundred Thousand Dollars ($500,000) under this Paragraph 7.8 and the approved plan hereunder."

Participants concluded that the language in the Consent Judgment does not constrain the restoration to spawning habitat for northern pike. Participants also agreed that the settlement amount of $500,000 should be used to provide the greatest benefit to the ecology and users of Tobico Marsh.

Participants discussed conceptual approaches to restoration in Tobico Marsh and agreed the restoration of natural hydrology in the Marsh while providing flood control should be the core concept pursued by the work group. Jim Baker proposed, and the group agreed, to the following general objective for hydrological restoration: "[f]acilitate to the extent practicable, natural fluctuations of water levels within Tobico Marsh, while providing adequate flood protection to residences riparian to Tobico Marsh."

- The participants also agreed that it is important to consider other ecological restoration projects and projects that will enhance public use.

2. Tobico Marsh Management and Institutional and Community Considerations

- Participants discussed the makeup of the work group with respect to the current Tobico Marsh management structure and determined that the County Drain Commissioner (Bill Rosebush) and the Bangor Township Supervisor should be invited to participate in future meetings of the technical work group and should be kept apprised of progress during the planning process.

In addition, close coordination may be necessary with Mr. Paul Wendler, a local resident who has been a very active participant in decision-making concerning the management of Tobico Marsh.

- Doug Reeves noted that Tobico Marsh was donated to the state as a refuge for waterfowl and that the state continues to manage it as such. The continued us of the marsh as a waterfowl refuge must be taken into account during restoration planning.

- Participants discussed the need for public participation and adherence to the NEPA process and determined that a public scoping meeting should be held in the near future (e.g., mid- to late-September).

3. Discussion of Restoration Options

- Discussion of restoration options focused on potential alterations to water-level controls and water-level management. Participants were briefed by MDNR staff regarding water-control structures and current issues regarding water levels, including the role of beavers in affecting water levels in the Tobico Marsh system. Participants also discussed problems affecting water flow and barriers to fish passage between the marsh system and Saginaw Bay.

- Participants discussed approaches and data needs to understanding the hydrology of the Tobico Marsh system: 1) getting accurate and precise elevations at all water control points and one or more locations in Saginaw Bay (e.g., from the U.S. Army Corps of Engineers), and 2) looking at actual water levels based on past studies such as the hydrological study completed in 1995 and Park personnel. Participants also agreed that it will be necessary to have accurate elevation data for locations that may be prone to flooding and acknowledged that some data collection efforts may be necessary.

4. Discussion of Planning Process

- Participants discussed the process for developing and implementing restoration plans under the Consent Judgment and agreed to follow the expedited process model that us currently being used for the boat launch and wetland/lakeplain prairie restoration projects.

Other Issues

- Mute swan eradication continues to be a management problem in Tobico Marsh because of the swan's aesthetic appeal to local residents.
- The muskrat population in Tobico Marsh appears to be depressed relative to other areas such as Crow Island. The reason(s) for this are not currently understood. A larger population of muskrats would benefit the marsh ecosystem by limiting the spread of both floating and rooted cattail stands.
- Waterfowl hunting is allowed in the extreme northern portion of the marsh (the majority of which is north of Parish road). There have been ongoing discussions regarding the extent of the hunting area.

Problems

- None.

Action Items

- MDNR will compile information on water levels in Tobico Marsh and transmit the data to Exponent/CRA as soon as practicable.
- Exponent/CRA and MDNR will coordinate efforts to obtain current and historical aerial photos and topographic maps.

- Exponent/CRA will perform a determination of special status species in the Tobico Marsh area.
- MDNR will send Exponent/CRA copies of engineering drawings for water control structures as soon as practicable.
- Exponent and CRA will review all available material regarding Tobico Marsh hydrology and develop a scope of work for filling data gaps, if any. The scope of work will be transmitted to the technical work group by August 13, 2001.
- Lisa Williams will begin preparing for a scoping meeting in mid- to late-September.

Attachment 1

Meeting Agenda

Proposed Agenda
First Technical Work Group Meeting for
Pike Spawning Habitat Restoration in Tobico Marsh
July 11, 2001
MDNR, Bay City, MI

- Introductions
- Consent Judgment Requirements and implementation process
- Tobico Marsh Management and institutional and community considerations
- Discussion of restoration options
- Discussion of planning process
- Action items

Attachment 2

Signup Sheet

Tobico Marsh Technical
Work Group Meeting
July 11 2001
MDNR Bay City

Name	Affiliation	Phone
Pieter Booth	Exponent	425/519 8709
Michael Tomka	CRA	519 884 0510
Donald Knorr	CRA	610 280 0277
Doug Reeves	DNR/Wildlife	989-684-9141 x803
MICHAEL EVANOFF	DNR/PARKS REC	989 684 3020
L William	US FWS	5 7 35 8324
Jim Baker	MDNR/Fisheries	989 684 9141 x807
Joe Medved	GM	810 634-10 6

APPENDIX B

1917 LETTER

Tierney Brothers,

Real Estate, Insurance

and Loans.

200-2-4 Fifth Avenue,

Bay City, Mich. Nov. 23, 1917.

W. B. Mershon,
Saginaw, Mich.

Dear Mr. Mershon:--

Enclosed please find record of hunting since your and Mr. Davis' last trips to Tobico. I had a nice season of hunting and enjoyed it and my health is better than it has been in ten years. I went to Tobico last Wednesday (Nov. 21) and it rained all day and I stayed in camp. It started to blow from the northwest at midnight and it was the worst storm on record. It washed out the D. & M. R. R. the whole length of Tobico. Just think, a man named Carrier and his wife and daughter lived in a cottage along side of the ice house. There was a big fishing boat on the shore. They all got into it and went over the track and the fence and landed down near where the big Pine tree was and waded a-shore and came to Green's camp and got dried out and they were about all in. The water was within five feet of our camps. But the best of all was the road coming out that the farmers made such a kick about is in fine shape and there was no water on the land near the road, so you can see how much harm the dam did to the farmers.

With best wishes, I am

Yours very truly,

Peter Tierney

APPENDIX C

CULVERT ANALYSIS CALCULATIONS

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

December 2, 2002

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)......................................	1.5
FHWA Chart Number..	2
FHWA Scale Number (Type of Culvert Entrance)................	3
Manning's Roughness Coefficient (n-value)...................	0.024
Entrance Loss Coefficient of Culvert Opening................	0.8
Culvert Length (ft)...	40.0
Invert Elevation at Downstream end of Culvert (ft)..........	0.0
Invert Elevation at Upstream end of Culvert (ft)............	0.2
Culvert Slope (ft/ft).......................................	0.005
Starting Flow Rate (cfs)....................................	1.0
Incremental Flow Rate (cfs).................................	1.0
Ending Flow Rate (cfs)......................................	16.0
Starting Tailwater Depth (ft)...............................	0.0
Incremental Tailwater Depth (ft)............................	0.0
Ending Tailwater Depth (ft).................................	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.52	0.61	0.51	0.37	0.37	2.92
2.0	0.0	0.77	0.88	0.75	0.53	0.53	3.55
3.0	0.0	0.99	1.11	0.97	0.66	0.66	4.02
4.0	0.0	1.19	1.32	1.22	0.77	0.77	4.41
5.0	0.0	1.39	1.52	1.5	0.86	0.86	4.77
6.0	0.0	1.58	1.75	1.5	0.95	0.95	5.11
7.0	0.0	1.78	1.82	1.5	1.02	1.02	5.44
8.0	0.0	2.02	2.12	1.5	1.1	1.1	5.78
9.0	0.0	2.24	2.45	1.5	1.16	1.16	6.13
10.0	0.0	2.58	2.8	1.5	1.22	1.22	6.5
11.0	0.0	2.95	3.18	1.5	1.27	1.27	6.89
12.0	0.0	3.36	3.58	1.5	1.31	1.31	7.31
13.0	0.0	3.8	4.01	1.5	1.35	1.35	7.76
14.0	0.0	4.28	4.46	1.5	1.38	1.38	8.23
15.0	0.0	4.79	4.94	1.5	1.41	1.41	8.72
16.0	0.0	5.34	5.46	1.5	1.42	1.42	9.23

18" CSP

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

December 2, 2002

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)......................................	2.0
FHWA Chart Number..	2
FHWA Scale Number (Type of Culvert Entrance)...............	3
Manning's Roughness Coefficient (n-value)..................	0.024
Entrance Loss Coefficient of Culvert Opening...............	0.8
Culvert Length (ft)..	40.0
Invert Elevation at Downstream end of Culvert (ft).........	0.0
Invert Elevation at Upstream end of Culvert (ft)...........	0.2
Culvert Slope (ft/ft)......................................	0.005
Starting Flow Rate (cfs)...................................	1.0
Incremental Flow Rate (cfs)................................	1.0
Ending Flow Rate (cfs).....................................	31.0
Starting Tailwater Depth (ft)..............................	0.0
Incremental Tailwater Depth (ft)...........................	0.0
Ending Tailwater Depth (ft)................................	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.47	0.55	0.46	0.34	0.34	2.77
2.0	0.0	0.68	0.79	0.65	0.49	0.49	3.34
3.0	0.0	0.86	0.98	0.81	0.6	0.6	3.75
4.0	0.0	1.01	1.14	0.96	0.7	0.7	4.07
5.0	0.0	1.16	1.29	1.09	0.79	0.79	4.35
6.0	0.0	1.3	1.44	1.22	0.87	0.87	4.6
7.0	0.0	1.43	1.57	1.36	0.94	0.94	4.83
8.0	0.0	1.56	1.7	1.52	1.01	1.01	5.05
9.0	0.0	1.69	1.83	1.72	1.07	1.07	5.26
10.0	0.0	1.82	1.95	2.0	1.13	1.13	5.45
11.0	0.0	1.95	2.08	2.0	1.19	1.19	5.65
12.0	0.0	2.07	2.21	2.0	1.24	1.24	5.84
13.0	0.0	2.2	2.35	2.0	1.3	1.3	6.03
14.0	0.0	2.32	2.5	2.0	1.35	1.35	6.22
15.0	0.0	2.45	2.34	2.0	1.4	2.0	4.77
16.0	0.0	2.62	2.5	2.0	1.44	2.0	5.09
17.0	0.0	2.77	2.66	2.0	1.49	2.0	5.41
18.0	0.0	2.89	2.82	2.0	1.53	2.0	5.73
19.0	0.0	3.1	2.99	2.0	1.57	2.0	6.05
20.0	0.0	3.32	3.17	2.0	1.61	2.0	6.37
21.0	0.0	3.55	3.36	2.0	1.64	2.0	6.68
22.0	0.0	3.79	3.55	2.0	1.68	2.0	7.0
23.0	0.0	4.04	3.74	2.0	1.71	2.0	7.32
24.0	0.0	4.3	3.95	2.0	1.74	2.0	7.64
25.0	0.0	4.58	4.16	2.0	1.76	2.0	7.96
26.0	0.0	4.86	4.36	2.0	1.79	2.0	8.28
27.0	0.0	5.16	4.58	2.0	1.81	2.0	8.59
28.0	0.0	5.47	4.81	2.0	1.83	2.0	8.91
29.0	0.0	5.79	5.04	2.0	1.85	2.0	9.23
30.0	0.0	6.12	5.28	2.0	1.86	2.0	9.55
31.0	0.0	6.46	5.53	2.0	1.88	2.0	9.87

24" CSP

BOX CULVERT ANALYSIS

COMPUTATION OF CULVERT PERFORMANCE CURVE

December 2, 2002

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Span (ft)..	10.0
Culvert Rise (ft)..	4.0
FHWA Chart Number..	10
FHWA Scale Number (Type of Culvert Entrance)................	1
Manning's Roughness Coefficient (n-value)..................	0.013
Entrance Loss Coefficient of Culvert Opening................	0.5
Culvert Length (ft)......................................	40.0
Invert Elevation at Downstream end of Culvert (ft)..........	0.0
Invert Elevation at Upstream end of Culvert (ft)............	0.2
Culvert Slope (ft/ft)....................................	0.005
Starting Flow Rate (cfs).................................	200.0
Incremental Flow Rate (cfs)..............................	5.0
Ending Flow Rate (cfs)...................................	450.0
Starting Tailwater Depth (ft)............................	0.0
Incremental Tailwater Depth (ft).........................	0.0
Ending Tailwater Depth (ft)..............................	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
200.0	0.0	3.8	0.0	1.97	2.32	1.97	10.17
205.0	0.0	3.86	0.0	2.0	2.36	2.0	10.25
210.0	0.0	3.92	0.0	2.03	2.39	2.03	10.33
215.0	0.0	3.98	0.0	2.07	2.43	2.07	10.41
220.0	0.0	4.04	0.0	2.1	2.47	2.1	10.49
225.0	0.0	4.11	0.0	2.13	2.51	2.13	10.56
230.0	0.0	4.17	0.0	2.16	2.54	2.16	10.63
235.0	0.0	4.23	0.0	2.19	2.58	2.19	10.71
240.0	0.0	4.29	0.0	2.23	2.62	2.23	10.78
245.0	0.0	4.35	0.0	2.26	2.65	2.26	10.85
250.0	0.0	4.4	0.0	2.29	2.69	2.29	10.92
255.0	0.0	4.46	0.0	2.32	2.72	2.32	10.99
260.0	0.0	4.52	0.0	2.35	2.76	2.35	11.05
265.0	0.0	4.58	0.0	2.38	2.79	2.38	11.12
270.0	0.0	4.64	0.0	2.41	2.83	2.41	11.18
275.0	0.0	4.69	0.0	2.45	2.86	2.45	11.25
280.0	0.0	4.75	0.0	2.48	2.9	2.48	11.31
285.0	0.0	4.85	0.0	2.51	2.93	2.51	11.37
290.0	0.0	4.95	0.0	2.54	2.97	2.54	11.43
295.0	0.0	5.05	0.0	2.57	3.0	2.57	11.49
300.0	0.0	5.15	0.0	2.6	3.04	2.6	11.55
305.0	0.0	5.25	0.0	2.63	3.07	2.63	11.61
310.0	0.0	5.35	0.0	2.66	3.1	2.66	11.67
315.0	0.0	5.45	0.0	2.69	3.14	2.69	11.72
320.0	0.0	5.55	0.0	2.72	3.17	2.72	11.78
325.0	0.0	5.63	0.0	2.75	3.2	2.75	11.84
330.0	0.0	5.7	0.0	2.78	3.23	2.78	11.89
335.0	0.0	5.78	0.0	2.8	3.27	2.8	11.94
340.0	0.0	5.86	0.0	2.83	3.3	2.83	12.0
345.0	0.0	5.94	0.0	2.86	3.33	2.86	12.05
350.0	0.0	6.02	0.0	2.89	3.36	2.89	12.1
355.0	0.0	6.1	0.0	2.92	3.4	2.92	12.15
360.0	0.0	6.19	0.0	2.95	3.43	2.95	12.2
365.0	0.0	6.27	0.0	2.98	3.46	2.98	12.25
370.0	0.0	6.36	0.0	3.01	3.49	3.01	12.3
375.0	0.0	6.45	0.0	3.04	3.52	3.04	12.35

10' x 4'
Box Culvert

[illegible]	0.0	6.53	0.0	3.07	3.55	3.07	12.4
385.0	0.0	6.62	0.0	3.09	3.58	3.09	12.45
390.0	0.0	6.71	0.0	3.12	3.62	3.12	12.49
395.0	0.0	6.81	0.0	3.15	3.65	3.15	12.54
400.0	0.0	6.9	0.0	3.18	3.68	3.18	12.58
405.0	0.0	6.99	0.0	3.21	3.71	3.21	12.63
410.0	0.0	7.09	0.0	3.23	3.74	3.23	12.67
415.0	0.0	7.19	0.0	3.26	3.77	3.26	12.72
420.0	0.0	7.28	0.0	3.29	3.8	3.29	12.76
425.0	0.0	7.38	0.0	3.32	3.83	3.32	12.81
430.0	0.0	7.48	0.0	3.35	3.86	3.35	12.85
435.0	0.0	7.58	0.0	3.37	3.89	3.37	12.89
440.0	0.0	7.69	0.0	3.4	3.92	3.4	12.93
445.0	0.0	7.79	0.0	3.43	3.95	3.43	12.97
450.0	0.0	7.9	0.0	3.46	3.98	3.46	13.01

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PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

December 2, 2002

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)......................................	4.0
FHWA Chart Number..	1
FHWA Scale Number (Type of Culvert Entrance)................	3
Manning's Roughness Coefficient (n-value)...................	0.013
Entrance Loss Coefficient of Culvert Opening................	0.5
Culvert Length (ft)..	40.0
Invert Elevation at Downstream end of Culvert (ft)..........	0.0
Invert Elevation at Upstream end of Culvert (ft)............	0.2
Culvert Slope (ft/ft)......................................	0.005
Starting Flow Rate (cfs)...................................	100.0
Incremental Flow Rate (cfs)................................	2.0
Ending Flow Rate (cfs).....................................	150.0
Starting Tailwater Depth (ft)..............................	0.0
Incremental Tailwater Depth (ft)...........................	0.0
Ending Tailwater Depth (ft)................................	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Headwater (ft) Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
100.0	0.0	4.78	5.21	3.22	3.03	3.03	9.79
102.0	0.0	4.84	5.28	3.29	3.06	3.06	9.89
104.0	0.0	4.92	5.36	3.37	3.09	3.09	9.99
106.0	0.0	5.01	5.43	3.46	3.12	3.12	10.09
108.0	0.0	5.09	5.5	3.58	3.14	3.14	10.19
110.0	0.0	5.18	5.58	4.0	3.17	3.17	10.3
112.0	0.0	5.27	5.65	4.0	3.2	3.2	10.4
114.0	0.0	5.36	5.73	4.0	3.22	3.22	10.5
116.0	0.0	5.45	5.81	4.0	3.25	3.25	10.61
118.0	0.0	5.55	5.89	4.0	3.27	3.27	10.72
120.0	0.0	5.64	5.97	4.0	3.3	3.3	10.83
122.0	0.0	5.74	6.05	4.0	3.32	3.32	10.94
124.0	0.0	5.84	6.13	4.0	3.35	3.35	11.05
126.0	0.0	5.94	6.21	4.0	3.37	3.37	11.16
128.0	0.0	6.04	6.3	4.0	3.39	3.39	11.27
130.0	0.0	6.14	6.38	4.0	3.41	3.41	11.39
132.0	0.0	6.25	6.47	4.0	3.43	3.43	11.5
134.0	0.0	6.35	6.56	4.0	3.45	3.45	11.62
136.0	0.0	6.46	6.65	4.0	3.47	3.47	11.74
138.0	0.0	6.57	6.75	4.0	3.49	3.49	11.86
140.0	0.0	6.68	6.84	4.0	3.51	3.51	11.98
142.0	0.0	6.8	6.94	4.0	3.53	3.53	12.1
144.0	0.0	6.91	7.05	4.0	3.55	3.55	12.22
146.0	0.0	7.03	5.06	4.0	3.56	4.0	11.62
148.0	0.0	7.15	5.11	4.0	3.58	4.0	11.78
150.0	0.0	7.27	5.16	4.0	3.6	4.0	11.94

48" CONCRETE PIPE

PIPE CULVERT ANALYSIS
COMPUTATION OF CULVERT PERFORMANCE CURVE

December 2, 2002

PROGRAM INPUT DATA

DESCRIPTION	VALUE
Culvert Diameter (ft)	8.0
FHWA Chart Number	2
FHWA Scale Number (Type of Culvert Entrance)	3
Manning's Roughness Coefficient (n-value)	0.024
Entrance Loss Coefficient of Culvert Opening	0.8
Culvert Length (ft)	40.0
Invert Elevation at Downstream end of Culvert (ft)	0.0
Invert Elevation at Upstream end of Culvert (ft)	0.2
Culvert Slope (ft/ft)	0.005
Starting Flow Rate (cfs)	1.0
Incremental Flow Rate (cfs)	10.0
Ending Flow Rate (cfs)	601.0
Starting Tailwater Depth (ft)	0.0
Incremental Tailwater Depth (ft)	0.0
Ending Tailwater Depth (ft)	0.0

COMPUTATION RESULTS

Flow Rate (cfs)	Tailwater Depth (ft)	Headwater (ft) Inlet Control	Outlet Control	Normal Depth (ft)	Critical Depth (ft)	Depth at Outlet (ft)	Outlet Velocity (fps)
1.0	0.0	0.3	0.38	0.31	0.24	0.24	2.28
11.0	0.0	1.06	1.25	0.97	0.8	0.8	4.19
21.0	0.0	1.49	1.74	1.33	1.11	1.11	4.96
31.0	0.0	1.83	2.12	1.61	1.36	1.36	5.5
41.0	0.0	2.13	2.46	1.85	1.56	1.56	5.92
51.0	0.0	2.4	2.75	2.07	1.75	1.75	6.28
61.0	0.0	2.65	3.03	2.26	1.92	1.92	6.6
71.0	0.0	2.88	3.28	2.45	2.07	2.07	6.88
81.0	0.0	3.1	3.52	2.62	2.22	2.22	7.14
91.0	0.0	3.32	3.74	2.79	2.35	2.35	7.38
101.0	0.0	3.52	3.96	2.94	2.48	2.48	7.6
111.0	0.0	3.72	4.17	3.1	2.61	2.61	7.81
121.0	0.0	3.92	4.37	3.25	2.73	2.73	8.01
131.0	0.0	4.1	4.56	3.39	2.84	2.84	8.2
141.0	0.0	4.29	4.75	3.54	2.95	2.95	8.38
151.0	0.0	4.47	4.93	3.68	3.06	3.06	8.55
161.0	0.0	4.65	5.11	3.82	3.16	3.16	8.72
171.0	0.0	4.83	5.28	3.95	3.26	3.26	8.88
181.0	0.0	5.0	5.46	4.08	3.36	3.36	9.03
191.0	0.0	5.17	5.62	4.22	3.46	3.46	9.19
201.0	0.0	5.34	5.79	4.35	3.55	3.55	9.34
211.0	0.0	5.51	5.95	4.49	3.64	3.64	9.48
221.0	0.0	5.68	6.11	4.62	3.73	3.73	9.62
231.0	0.0	5.84	6.27	4.75	3.82	3.82	9.76
241.0	0.0	6.0	6.42	4.89	3.9	3.9	9.9
251.0	0.0	6.17	6.58	5.02	3.99	3.99	10.03
261.0	0.0	6.33	6.73	5.16	4.07	4.07	10.16
271.0	0.0	6.49	6.88	5.29	4.15	4.15	10.29
281.0	0.0	6.65	7.03	5.43	4.23	4.23	10.42
291.0	0.0	6.81	7.17	5.58	4.31	4.31	10.55
301.0	0.0	6.97	7.32	5.73	4.38	4.38	10.67
311.0	0.0	7.13	7.47	5.88	4.46	4.46	10.8
321.0	0.0	7.29	7.61	6.04	4.53	4.53	10.92
331.0	0.0	7.45	7.76	6.21	4.61	4.61	11.04
341.0	0.0	7.61	7.9	6.39	4.68	4.68	11.16
351.0	0.0	7.76	8.04	6.59	4.75	4.75	11.29
361.0	0.0	7.92	8.18	6.83	4.82	4.82	11.4

8' CSP.

[illegible]	0.0	8.08	8.33	7.14	4.89	4.89	11.52
381.0	0.0	8.24	8.47	8.0	4.96	4.96	11.64
391.0	0.0	8.4	8.61	8.0	5.03	5.03	11.76
401.0	0.0	8.55	8.75	8.0	5.09	5.09	11.88
411.0	0.0	8.71	8.89	8.0	5.16	5.16	12.0
421.0	0.0	8.87	9.03	8.0	5.22	5.22	12.11
431.0	0.0	9.03	9.17	8.0	5.29	5.29	12.23
441.0	0.0	9.18	9.31	8.0	5.35	5.35	12.35
451.0	0.0	9.34	9.46	8.0	5.41	5.41	12.47
461.0	0.0	9.5	9.6	8.0	5.47	5.47	12.59
471.0	0.0	9.66	9.74	8.0	5.53	5.53	12.7
481.0	0.0	9.82	9.88	8.0	5.59	5.59	12.82
491.0	0.0	9.98	10.03	8.0	5.65	5.65	12.94
501.0	0.0	10.18	10.17	8.0	5.71	8.0	9.97
511.0	0.0	10.44	10.31	8.0	5.76	8.0	10.17
521.0	0.0	10.67	10.46	8.0	5.82	8.0	10.36
531.0	0.0	10.88	10.61	8.0	5.87	8.0	10.56
541.0	0.0	11.05	10.76	8.0	5.93	8.0	10.76
551.0	0.0	11.2	10.9	8.0	5.98	8.0	10.96
561.0	0.0	11.31	11.06	8.0	6.04	8.0	11.16
571.0	0.0	11.44	11.21	8.0	6.09	8.0	11.36
581.0	0.0	11.69	11.36	8.0	6.14	8.0	11.56
591.0	0.0	11.94	11.52	8.0	6.19	8.0	11.76
601.0	0.0	12.21	11.68	8.0	6.24	8.0	11.96

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APPENDIX D

HISTORIC REPAIR AND MAINTENANCE OF BAY COUNTY DRAINS

171

LESPERANCE DRAIN
Kawkawlin Township

Now called LESPERANCE - REZLER - TAYLOR

No. 40	Liber A	1894 Clean out	
No. 13	Liber A	Established 1900	
Book No. E	Page 1	1900 Clean out	
Book No. 6	Page 759	1923 Clean out	
No. 280	Liber B	" "	
Book No. 7	Pp. 201-718	1925, 1927 Re-assessments	
Book No. 9	Page 346	1930 Re-assessment	
No. 137	Liber C	1925, 1927, 1930 Re-assessments (above)	
Safe K		1952 Assessment	
Roll 027	Pp. 90-111	1956-7 Clean out	Liber D, File 49
		1982 Clean out, assessment (with Rezler, Taylor)	
		Sprayed 1991, 1997	
		Petition taken out 1993, not returned	

NO right of way

086
DUBAY DRAIN
Kawkawlin Township

Book No. F	Page 2	Established 1901	
No. 22	Liber A	1901 Clean out	
Book No. 4	Page 241	1913 Clean out, relocation of outlet	
No.154	Liber B	" " "	
No. 43	Liber C	1931 Clean out, relocation	
Book No. 17	Page 39	1951 Clean out, assessment	
Roll 024	Pp. 100-104	1960 Petition for clean out denied	Liber D File 18
Book No. 24	Page 199	Copies of above petition	
		1995 Clean out	
		1996 Clean out, Assessment	
		Sprayed 1997	

RELEASE OF RIGHT OF WAY

Book No. C	Page 99	1913

326
WETTERS DRAIN
Kawkawlin Township

No. 155	Liber B	Established 1913	
Book No. 4	Page 259	Established 1915	
Book No. 21	Page 241-4	1955-6 Assessment	
Book No. 24	Page 529	1961 Clean out	
Roll 024	Pp. 265-297	" "	Liber D, File 25
		1985 Clean out, assessment	

RELEASE OF RIGHT OF WAY

Book No. C	Page 105	1913
Book No. 24	Page 565	1961
Book No. F	Page 484	1985

APPENDIX E

HYDROLOGIC ANALYSIS INFORMATION

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Bay County, Michigan

Map symbol	Soil name	Acres	Percent
12	Corunna-Tappan Sandy Loams	7,688	2.6
13	Belleville Loamy Sand	17,577	6.0
16	Essexville Loamy Sand	4,954	1.7
17A	Wixom Loamy Sand, 0 To 3 Percent Slopes	24,912	8.6
23	Tappan Loam	81,629	28.0
25A	Pipestone Fine Sand, Loamy Substratum, 0 To 3 Percent Slopes	5,809	2.0
31	Sloan Loam	1,549	0.5
35A	Pipestone Fine Sand, 0 To 3 Percent Slopes	13,726	4.7
37B	Rousseau Fine Sand, 0 To 6 Percent Slopes	4,941	1.7
43A	Londo Loam, 0 To 1 Percent Slopes	32,591	11.2
49A	Londo-Poseyville Complex, 0 To 3 Percent Slopes	25,252	8.7
50	Cohoctah Loamy Fine Sand	3,136	1.1
51	Urban Land	1,659	0.6
52	Urban Land-Tappan Complex	3,897	1.3
53A	Urban Land-Londo Complex, 0 To 1 Percent Slopes	2,129	0.7
54B	Urban Land-Rousseau Complex, 0 To 6 Percent Slopes	456	0.2
55	Aquents,sandy And Loamy	3,781	1.3
56	Dumps	333	0.1
57A	Poseyville Loamy Sand, 0 To 3 Percent Slopes	4,543	1.6
58A	Tappan-Poseyville Complex, 0 To 3 Percent Slopes	19,438	6.7
59	Tobico Fine Sand	5,874	2.0
60	Urban Land-Essexville Complex	1,334	0.5
61	Cohoctah Fine Sandy Loam	1,150	0.4
62A	Sanilac-Bach Very Fine Sandy Loams, 0 To 3 Percent Slopes	1,329	0.5
63A	Rapson-Bach Complex, 0 To 3 Percent Slopes	1,775	0.6
64B	Londo-Wixom Complex, 0 To 4 Percent Slopes	3,875	1.3
65B	Guelph-Menominee Complex, 2 To 8 Percent Slopes	2,473	0.8
66A	Pipestone-Tobico Fine Sands, 0 To 3 Percent Slopes	3,557	1.2
67	Belleville Loamy Sand, Ponded	856	0.3
68	Cohoctah Loamy Fine Sand, Rarely Flooded	409	0.1
W	Water	8,408	2.9
	Total	291,040	100.0

* Less than 0.1 percent.

Nontechnical Soil Descriptions

Bay County, Michigan

Nontechnical soil descriptions describe soil properties to a soil map unit or group of map units, shown in the NonTechnical Descriptions report. These descriptions are written in terminology that Non-technical users of soil survey information can understand.

12 - Corunna-Tappan Sandy Loams

The Corunna soil is poorly drained. This soil formed in loamy material. It is on glacial lake plains and till plains. The permeability is moderate or moderately rapid in the upper part of the soil and moderate or moderately slow in the lower part. The available water capacity is high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Tappan soil is poorly drained. This soil formed in loamy material. It is on glacial till plains and moraines. The permeability is moderate or moderately slow in the upper part of the soil and slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

13 - Belleville Loamy Sand

The Belleville soil is poorly or very poorly drained. This soil formed in sandy deposits 20 to 40 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is low to high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

16 - Essexville Loamy Sand

The Essexville soil is poorly or very poorly drained. This soil formed in sandy deposits 18 to 35 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

17A - Wixom Loamy Sand, 0 To 3 Percent Slopes

The Wixom soil is somewhat poorly drained. This soil formed in sandy deposits 20 to 40 inches thick over loamy material. It is on glacial till plains, outwash plains and lake plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is low to high. The surface runoff is slow. The seasonal high water table fluctuates between .5 to 1.5 feet of the surface during prolonged wet periods.

23 - Tappan Loam

The Tappan soil is poorly drained. This soil formed in loamy material. It is on glacial till plains and moraines. The permeability is moderate or moderately slow in the upper part of the soil and slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

Nontechnical Soil Descriptions--Continued

25A - Pipestone Fine Sand, Loamy Substratum, 0 To 3 Percent Slopes

The Pipestone, loamy substratum soil is somewhat poorly drained. This soil formed in sandy deposits greater than 40 inches thick over loamy material. It is on glacial outwash plains, lake plains, beach ridges and till plains. The permeability is rapid. The available water capacity is low. The surface runoff is slow or very slow. The seasonal high water table fluctuates between .5 to 1.5 feet of the surface during prolonged wet periods.

31 - Sloan Loam

The Sloan soil is very poorly drained. This soil formed in loamy material on floodplains. The permeability is moderate or moderately slow. The available water capacity is high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding. It is also subject to common floodings for brief periods.

35A - Pipestone Fine Sand, 0 To 3 Percent Slopes

The Pipestone soil is somewhat poorly drained. This soil formed in sandy material. It is on glacial outwash plains, lake plains, beach ridges and till plains. The permeability is rapid. The available water capacity is low. The surface runoff is slow or very slow. The seasonal high water table fluctuates between .5 to 1.5 feet of the surface during prolonged wet periods.

37B - Rousseau Fine Sand, 0 To 6 Percent Slopes

The Rousseau soil is moderately well drained. This soil formed in sandy material. It is on glacial lake sand dunes, lake plains and outwash plains. The permeability is rapid. The available water capacity is low. The surface runoff is slow or very slow. The seasonal high water table fluctuates from 2.5 to 6 of the surface during prolonged wet periods.

43A - Londo Loam, 0 To 1 Percent Slopes

The Londo soil is somewhat poorly drained. This soil formed in loamy material. It is on low glacial moraines and till plains. The permeability is moderate or moderately slow. The available water capacity is moderate or high. The surface runoff is slow to medium depending on the slope. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

49A - Londo-Poseyville Complex, 0 To 3 Percent Slopes

The Poseyville soil is somewhat poorly drained. This soil formed in sandy deposits 13 to 24 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderate or moderately slow in the lower part. The available water capacity is low or moderate. The surface runoff is slow. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.
The Londo soil is somewhat poorly drained. This soil formed in loamy material. It is on low glacial moraines and till plains. The permeability is moderate or moderately slow. The available water capacity is moderate or high. The surface runoff is slow to medium depending on the slope. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

50 - Cohoctah Loamy Fine Sand

The Cohoctah soil is poorly or very poorly drained. This soil formed in loamy material on floodplains. The permeability is moderately rapid. The available water capacity is moderate. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding. It is also subject to common floodings for brief to long periods.

51 - Urban Land

The Urban Land map unit is a miscellaneous land type. This area is may be covered by commercial buildings, condominiums and apartment buildings, parking lots, streets, sidewalks, driveways, railroad yards, industrial complexes and other structures.

52 - Urban Land-Tappan Complex

The Tappan soil is poorly drained. This soil formed in loamy material. It is on glacial till plains and moraines. The permeability is moderate or moderately slow in the upper part of the soil and slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Urban Land map unit is a miscellaneous land type. This area is may be covered by commercial buildings, condominiums and apartment buildings, parking lots, streets, sidewalks, driveways, railroad yards, industrial complexes and other structures.

53A - Urban Land-Londo Complex, 0 To 1 Percent Slopes

The Londo soil is somewhat poorly drained. This soil formed in loamy material. It is on low glacial moraines and till plains. The permeability is moderate or moderately slow. The available water capacity is moderate or high. The surface runoff is slow to medium depending on the slope. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.
The Urban Land map unit is a miscellaneous land type. This area is may be covered by commercial buildings, condominiums and apartment buildings, parking lots, streets, sidewalks, driveways, railroad yards, industrial complexes and other structures.

54B - Urban Land-Rousseau Complex, 0 To 6 Percent Slopes

The Rousseau soil is well drained. This soil formed in sandy material. It is on glacial lake sand dunes, lake plains and outwash plains. The permeability is rapid. The available water capacity is low. The surface runoff is slow or very slow.
The Urban Land map unit is a miscellaneous land type. This area is may be covered by commercial buildings, condominiums and apartment buildings, parking lots, streets, sidewalks, driveways, railroad yards, industrial complexes and other structures.

55 - Aquents,sandy And Loamy

Aquents, sandy and loamy are poorly drained and very poorly drained soils formed in outwash plains, till plains, lake plains and moraines. These soils have been greatly altered by leveling.They vary in color, texture and thickness of individual layers.

56 - Dumps

Dumps are a miscellaneous map unit. These areas are filled with refuse and trash. Most areas are active landfills and do not have vegetative cover. In some places layers of soil material cover the refuse.

57A - Poseyville Loamy Sand, 0 To 3 Percent Slopes

The Poseyville soil is somewhat poorly drained. This soil formed in sandy deposits 13 to 24 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderate or moderately slow in the lower part. The available water capacity is low or moderate. The surface runoff is slow. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

58A - Tappan-Poseyville Complex, 0 To 3 Percent Slopes

The Poseyville soil is somewhat poorly drained. This soil formed in sandy deposits 13 to 24 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderate or moderately slow in the lower part. The available water capacity is low or moderate. The surface runoff is slow. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.
The Tappan soil is poorly drained. This soil formed in loamy material. It is on glacial till plains and moraines. The permeability is moderate or moderately slow in the upper part of the soil and slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

Nontechnical Soil Descriptions--Continued

59 - Tobico Fine Sand

The Tobico soil is poorly or very poorly drained. This soil formed in sandy material. It is on glacial outwash plains and lake benches. The permeability is rapid. The available water capacity is low. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.

60 - Urban Land-Essexville Complex

The Essexville soil is poorly or very poorly drained. This soil formed in sandy deposits 18 to 35 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is moderate or high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Urban Land map unit is a miscellaneous land type. This area is may be covered by commercial buildings, condominiums and apartment buildings, parking lots, streets, sidewalks, driveways, railroad yards, industrial complexes and other structures.

61 - Cohoctah Fine Sandy Loam

The Cohoctah soil is poorly or very poorly drained. This soil formed in loamy material on floodplains. The permeability is moderately rapid. The available water capacity is moderate. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding. It is also subject to common floodings for brief to long periods.

62A - Sanilac-Bach Very Fine Sandy Loams, 0 To 3 Percent Slopes

The Bach soil is poorly drained or very poorly drained. This soil formed in sandy, loamy and silty material. It is on glacial lake plains. The permeability is moderate or moderately slow. The available water capacity is high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Sanilac soil is somewhat poorly drained. This soil formed in loamy and silty deposits 10 to 40 inches over stratified loamy, silty and sandy material. It is on glacial lake plains and drainageways. The permeability is moderate or moderately slow. The surface runoff is slow. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

63A - Rapson-Bach Complex, 0 To 3 Percent Slopes

The Bach soil is poorly drained or very poorly drained. This soil formed in sandy, loamy and silty material. It is on glacial lake plains. The permeability is moderate or moderately slow. The available water capacity is high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Rapson soil is somewhat poorly drained. This soil formed in sandy deposits 20 to 38 inches thick over stratified sandy, silty and loamy material. It is on glacial outwash plains, lake plains and beach ridges. The permeability is rapid in the upper part of the profile and moderate in the lower part. The available water capacity is low to high. The surface runoff is very slow or slow. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

Nontechnical Soil Descriptions--Continued

64B - Londo-Wixom Complex, 0 To 4 Percent Slopes

The Wixom soil is somewhat poorly drained. This soil formed in sandy deposits 20 to 40 inches thick over loamy material. It is on glacial till plains, outwash plains and lake plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is low to high. The surface runoff is slow. The seasonal high water table fluctuates between .5 to 1.5 feet of the surface during prolonged wet periods.
The Londo soil is somewhat poorly drained. This soil formed in loamy material. It is on low glacial moraines and till plains. The permeability is moderate or moderately slow. The available water capacity is moderate or high. The surface runoff is slow to medium depending on the slope. The seasonal high water table fluctuates between 1 to 2 feet of the surface during prolonged wet periods.

65B - Guelph-Menominee Complex, 2 To 8 Percent Slopes

The Menominee soil is well drained. This soil formed in sandy deposits 20 to 40 inches over loamy material. It is on glacial moraines, till plains, outwash plains and lake plains. The permeability is rapid in the upper part of the soil and moderate or moderately slow in the lower part. The available water capacity is low to moderate. The surface runoff is very slow to medium depending on slope.
The Guelph soil is well drained. This soil formed in loamy material. It is on glacial moraines and till plains. The permeability is moderately slow. The available water capacity is moderate or high. The surface runoff is medium to very rapid depending on the slope.

66A - Pipestone-Tobico Fine Sands, 0 To 3 Percent Slopes

The Tobico soil is poorly or very poorly drained. This soil formed in sandy material. It is on glacial outwash plains and lake benches. The permeability is rapid. The available water capacity is low. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface during prolonged wet periods. This soil is subject to frequent ponding.
The Pipestone soil is somewhat poorly drained. This soil formed in sandy material. It is on glacial outwash plains, lake plains, beach ridges and till plains. The permeability is rapid. The available water capacity is low. The surface runoff is slow or very slow. The seasonal high water table fluctuates between .5 to 1.5 feet of the surface during prolonged wet periods.

67 - Belleville Loamy Sand, Ponded

The Belleville, ponded soil is very poorly drained. This soil formed in sandy deposits 20 to 40 inches thick over loamy material. It is on glacial lake plains and till plains. The permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is low to high. The surface runoff is very slow or ponded. The seasonal high water table is at or near the surface most of the year. Only in the driest years do these areas dry up. This soil is subject to frequent ponding.

Water Features
Bay County, Michigan

(See text for definitions of terms used in this table. Upper limit, Lower limit, and Surface water depth are in feet. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated.)

Map symbol and soil name	Hydro-logic group	Month	Water Table Depth			Ponding			Flooding	
			Upper limit	Lower limit	Water table kind	Surface water depth	Duration	Frequency	Duration	Frequency
			Ft.	Ft.		Ft.				
12:										
Corunna	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
13:										
Belleville	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
16:										
Essexville	A/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
17A:										
Wixom	B	Jan-Jun	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
		Jul-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
23:										
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
25A:										
Pipestone	B	Jan-May	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
31:										
Sloan	B/D	Jan-Jun	0.0-1.0	> 6.0	Apparent	---	---	---	Brief	Frequent
		Jul-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Brief	Frequent
35A:										
Pipestone	B	Jan-Jun	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
37B:										
Rousseau	A	Jan	> 6.0	> 6.0	---	---	---	None	---	None
		Feb-May	2.5-6.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Dec	> 6.0	> 6.0	---	---	---	None	---	None
43A:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
49A:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None

Water Features--Continued

Map symbol and soil name	Hydro-logic group	Month	Water Table Depth: Upper limit	Water Table Depth: Lower limit	Water Table Depth: Water table kind	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft	Ft		Ft				
50:										
Cohoctah	B/D	Jan-Apr	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Frequent
		May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Frequent
51:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
52:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
53A:										
Urban Land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
54B:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Rousseau	A	Jan	> 6.0	> 6.0	---	---	---	None	---	None
		Feb-May	2.5-6.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Dec	> 6.0	> 6.0	---	---	---	None	---	None
55:										
Aquents	D	Jan-Dec	0.0	> 6.0	Apparent	0.0-1.0	Very long	Frequent	---	None
56:										
Dumps	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
57A:										
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
58A:										
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
59:										
Tobico	A/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
60:										
Essexville	A/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
61:										
Cohoctah	B/D	Jan-Apr	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Occasional
		May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Occasional

Water Features--Continued

Map symbol and soil name	Hydro-logic group	Month	Water Table Depth: Upper limit	Water Table Depth: Lower limit	Water Table Depth: Water table kind	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft	Ft		Ft				
62A:										
Sanilac	B	Jan-Jun	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Bach	B/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
63A:										
Rapson	B	Jan-May	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jun-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
Bach	B/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
64B:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Wixom	B	Jan-Jun	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
		Jul-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
65B:										
Geulph	B	Jan-Apr	2.5-6.0	3.0-4.0	Perched	---	---	None	---	None
		May-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	2.5-6.0	3.0-4.0	Perched	---	---	None	---	None
Menominee	A	Jan-Apr	2.5-4.0	3.0-4.0	Perched	---	---	None	---	None
		May-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	2.5-4.0	3.0-4.0	Perched	---	---	None	---	None
66A:										
Pipestone	B	Jan-Jun	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
Tobico	A/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
67:										
Belleville	D	Jan-Jul	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
68:										
Cohoctah	D	Jan-May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	Very brief	Rare
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
W:										
Water	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---

Water Features--Continued

ENDNOTE--WATER FEATURES

This table provides estimates of various water features. The estimates are used in land use planning that involves engineering considerations

HYDROLOGIC SOIL GROUPS are based on estimates of ronoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltrate rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils tha are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

WATER TABLE refers to a saturated zone in the soil. The table indicates by month, depth to the top (upper limit) and base (lower limit) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

PONDING is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates surface water depth and the duration and frequency of ponding. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, long if 7 to 30 days, and very long if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. None means that ponding is not probable; rare that is is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); occasional that is occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and frequent that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

FLOODING is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

DURATION AND FREQUENCY are estimated. Duration is expressed as extremely brief if 0.1 hour to 4 hours, very brief if 4 hours to 2 days, brief if 2 to 7 days, long if 7 to 30 days, and very long if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. None means that flooding is not probable; very rare that it is unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); rare that is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 1 percent to 5 percent in any year); occasional that is occurs infrequently under normal weather conditions (the chance of flooding is 5 to 20 percent in any year); frequent that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and very frequent that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development. Also considered are local information about the extent and levels of flooding and relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Water Features
Bay County, Michigan

(See text for definitions of terms used in this table. Upper limit, Lower limit, and Surface water depth are in feet. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated.)

Map symbol and soil name	Hydro-logic group	Month	Water Table Depth: Upper limit	Water Table Depth: Lower limit	Water Table Depth: Water table kind	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft.	Ft.		Ft.				
12:										
Corunna	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
13:										
Belleville	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
16:										
Essexville	A/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
17A:										
Wixom	B	Jan-Jun	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
		Jul-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
23:										
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
25A:										
Pipestone	B	Jan-May	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
31:										
Sloan	B/D	Jan-Jun	0.0-1.0	> 6.0	Apparent	---	---	---	Brief	Frequent
		Jul-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Brief	Frequent
35A:										
Pipestone	B	Jan-Jun	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
37B:										
Rousseau	A	Jan	> 6.0	> 6.0	---	---	---	None	---	None
		Feb-May	2.5-6.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Dec	> 6.0	> 6.0	---	---	---	None	---	None
43A:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
49A:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None

Water Features--Continued

Map symbol and soil name	Hydrologic group	Month	Water Table Depth: Upper limit	Water Table Depth: Lower limit	Water Table Depth: Water table kind	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft	Ft		Ft				
50:										
Cohoctah	B/D	Jan-Apr	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Frequent
		May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Frequent
51:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
52:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
53A:										
Urban Land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
54B:										
Urban land	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
Rousseau	A	Jan	> 6.0	> 6.0	---	---	---	None	---	None
		Feb-May	2.5-6.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Dec	> 6.0	> 6.0	---	---	---	None	---	None
55:										
Aquents	D	Jan-Dec	0.0	> 6.0	Apparent	0.0-1.0	Very long	Frequent	---	None
56:										
Dumps	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---
57A:										
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
58A:										
Tappan	B/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Sep	> 6.0	> 6.0	---	---	---	---	---	None
		Oct-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
Poseyville	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
59:										
Tobico	A/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
60:										
Essexville	A/D	Jan-May	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	---	---	None
		Nov-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
61:										
Cohoctah	B/D	Jan-Apr	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Occasional
		May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	Long	Occasional

Water Features--Continued

Map symbol and soil name	Hydro-logic group	Month	Water Table Depth: Upper limit	Lower limit	Water table kind	Ponding: Surface water depth	Duration	Frequency	Flooding: Duration	Frequency
			Ft.	Ft		Ft				
62A:										
Sanilac	B	Jan-Jun	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Bach	B/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
63A:										
Rapson	B	Jan-May	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jun-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
Bach	B/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
64B:										
Londo	C	Jan-May	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
		Jun-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	1.0-2.0	> 6.0	Apparent	---	---	None	---	None
Wixom	B	Jan-Jun	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
		Jul-Oct	> 6.0	> 6.0	---	---	---	None	---	None
		Nov-Dec	0.5-1.5	1.5-3.5	Perched	---	---	None	---	None
65B:										
Geulph	B	Jan-Apr	2.5-6.0	3.0-4.0	Perched	---	---	None	---	None
		May-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	2.5-6.0	3.0-4.0	Perched	---	---	None	---	None
Menominee	A	Jan-Apr	2.5-4.0	3.0-4.0	Perched	---	---	None	---	None
		May-Nov	> 6.0	> 6.0	---	---	---	None	---	None
		Dec	2.5-4.0	3.0-4.0	Perched	---	---	None	---	None
66A:										
Pipestone	B	Jan-Jun	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
		Jul-Sep	> 6.0	> 6.0	---	---	---	None	---	None
		Oct-Dec	0.5-1.5	> 6.0	Apparent	---	---	None	---	None
Tobico	A/D	Jan-Jun	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Jul-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
67:										
Belleville	D	Jan-Jul	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
		Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Dec	0.0	> 6.0	Apparent	0.0-1.0	Long	Occasional	---	None
68:										
Cohoctah	D	Jan-May	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
		Jun-Aug	> 6.0	> 6.0	---	---	---	---	---	None
		Sep-Oct	0.0-1.0	> 6.0	Apparent	---	---	---	Very brief	Rare
		Nov-Dec	0.0-1.0	> 6.0	Apparent	---	---	---	---	None
W:										
Water	---	Jan-Dec	> 6.0	> 6.0	---	---	---	---	---	---

Water Features--Continued

ENDNOTE--WATER FEATURES

This table provides estimates of various water features. The estimates are used in land use planning that involves engineering considerations

HYDROLOGIC SOIL GROUPS are based on estimates of ronoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms. The four hydrologic soil groups are:

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Group C. Soils having a slow infiltrate rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils tha are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

WATER TABLE refers to a saturated zone in the soil. The table indicates by month, depth to the top (upper limit) and base (lower limit) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

PONDING is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates surface water depth and the duration and frequency of ponding. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, long if 7 to 30 days, and very long if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. None means that ponding is not probable; rare that is is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); occasional that is occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and frequent that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

FLOODING is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

DURATION AND FREQUENCY are estimated. Duration is expressed as extremely brief if 0.1 hour to 4 hours, very brief if 4 hours to 2 days, brief if 2 to 7 days, long if 7 to 30 days, and very long if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. None means that flooding is not probable; very rare that it is unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); rare that is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 1 percent to 5 percent in any year); occasional that is occurs infrequently under normal weather conditions (the chance of flooding is 5 to 20 percent in any year); frequent that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and very frequent that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development. Also considered are local information about the extent and levels of flooding and relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Physical Properties of Soils
Bay County, Michigan

(Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply to the surface layer)

Map symbol and soil name	Depth	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Erosion factors K	Erosion factors Kf	Erosion factors T	Wind erodi- bility group	Wind erodi- bility index
	In	Pct	g/cc	in/hr	In/in	Pct					
12:											
Corunna---------	0-10	5-15	1.10-1.60	1.98-5.95	0.12-0.15	0.0-2.9	.20	.20	5	3	86
	10-29	10-18	1.30-1.60	0.57-5.95	0.08-0.14	0.0-2.9	.20	.20			
	29-60	18-35	1.45-1.70	0.20-0.57	0.16-0.20	3.0-5.9	.43	.43			
Tappan----------	0-10	12-20	1.20-1.60	1.98-5.95	0.12-0.15	0.0-2.9	.20	.20	5	3	86
	10-29	18-30	1.60-1.80	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	29-60	15-30	1.60-1.80	0.06-0.20	0.15-0.19	3.0-5.9	.37	.37			
13:											
Belleville------	0-11	3-12	0.90-1.60	5.95-19.98	0.10-0.12	0.0-2.9	.17	.17	4	2	134
	11-36	2-12	1.45-1.70	5.95-19.98	0.06-0.10	0.0-2.9	.17	.17			
	36-60	25-35	1.45-1.80	0.20-0.57	0.14-0.20	3.0-5.9	.32	.32			
16:											
Essexville------	0-11	10-15	1.35-1.50	5.95-19.98	0.10-0.14	0.0-2.9	.17	.17	5	2	134
	11-26	2-12	1.40-1.55	5.95-19.98	0.04-0.12	0.0-2.9	.17	.17			
	26-60	10-35	1.45-1.65	0.20-0.57	0.12-0.20	0.0-2.9	.32	.32			
17A:											
Wixom-----------	0-9	2-12	1.20-1.60	5.95-19.98	0.10-0.12	0.0-2.9	.17	.17	5	2	134
	9-26	2-14	1.40-1.70	5.95-19.98	0.06-0.11	0.0-2.9	.15	.15			
	26-60	18-35	1.50-1.70	0.20-0.57	0.14-0.20	0.0-2.9	.43	.43			
23:											
Tappan----------	0-10	15-25	1.20-1.60	0.57-1.98	0.18-0.22	3.0-5.9	.28	.28	5	5	56
	10-29	18-30	1.60-1.80	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	29-60	15-30	1.60-1.80	0.06-0.20	0.15-0.19	3.0-5.9	.37	.37			
25A:											
Pipestone-------	0-9	2-10	1.30-1.50	5.95-19.98	0.06-0.10	0.0-2.9	.15	.15	5	1	220
	9-55	2-12	1.20-1.60	5.95-19.98	0.04-0.08	0.0-2.9	.17	.17			
	55-60	12-35	1.40-1.70	0.06-0.57	0.16-0.18	0.0-2.9	.32	.32			
31:											
Sloan-----------	0-11	15-27	1.20-1.40	0.57-1.98	0.19-0.24	0.0-2.9	.28	.28	5	6	48
	11-60	22-35	1.25-1.55	0.20-1.98	0.15-0.19	3.0-5.9	.37	.37			
35A:											
Pipestone-------	0-4	2-12	1.30-1.50	5.95-19.98	0.07-0.10	0.0-2.9	.15	.15	5	1	220
	4-8	2-12	1.30-1.70	5.95-19.98	0.06-0.10	0.0-2.9	.15	.15			
	8-12	2-12	1.40-1.70	5.95-19.98	0.06-0.09	0.0-2.9	.15	.15			
	12-60	2-12	1.40-1.65	5.95-19.98	0.05-0.07	0.0-2.9	.15	.15			
37B:											
Rousseau--------	0-6	0-10	1.30-1.55	5.95-19.98	0.07-0.09	0.0-2.9	.15	.15	5	1	250
	6-23	0-10	1.30-1.60	1.98-19.98	0.06-0.11	0.0-2.9	.15	.15			
	23-60	0-10	1.50-1.65	5.95-19.98	0.05-0.07	0.0-2.9	.15	.15			
43A:											
Londo-----------	0-7	10-18	1.40-1.70	0.57-1.98	0.18-0.22	0.0-2.9	.32	.32	5	5	56
	7-20	20-35	1.40-1.75	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	20-60	20-32	1.45-1.75	0.20-1.98	0.12-0.19	3.0-5.9	.32	.32			
49A:											
Londo-----------	0-7	10-18	1.40-1.70	0.57-1.98	0.18-0.22	0.0-2.9	.32	.32	5	5	56
	7-20	20-35	1.40-1.75	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	20-60	20-32	1.45-1.75	0.20-1.98	0.12-0.19	3.0-5.9	.32	.32			
Poseyville------	0-7	2-12	1.30-1.50	5.95-19.98	0.09-0.12	0.0-2.9	.17	.17	5	2	134
	7-22	12-18	1.55-1.70	0.57-1.98	0.06-0.14	0.0-2.9	.24	.24			
	22-60	18-35	1.45-1.70	0.20-1.98	0.12-0.19	3.0-5.9	.37	.37			

Physical Properties of Soils--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Erosion factors K	Erosion factors Kf	Erosion factors T	Wind erodi- bility group	Wind erodi- bility index
	In	Pct	g/cc	in/hr	In/in	Pct					
[illegible]											
Cohoctah--------	0-11	0-15	1.20-1.50	5.95-19.98	0.10-0.15	0.0-2.9	.17	.17	5	2	134
	11-18	5-18	1.45-1.65	1.98-5.95	0.12-0.20	0.0-2.9	.28	.28			
	18-60	2-18	1.45-1.65	1.98-5.95	0.08-0.20	0.0-2.9	.28	.28			
51:											
Urban land------	---	---	---	---	---	---	---	---	-	---	---
52:											
Urban land------	---	---	---	---	---	---	---	---	-	---	---
Tappan----------	0-10	15-25	1.20-1.60	0.57-1.98	0.18-0.22	3.0-5.9	.28	.28	5	5	56
	10-29	18-30	1.60-1.80	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	29-60	15-30	1.60-1.80	0.06-0.20	0.15-0.19	3.0-5.9	.37	.37			
53A:											
Urban land------	---	---	---	---	---	---	---	---	-	---	---
Londo-----------	0-7	10-18	1.40-1.70	0.57-1.98	0.18-0.22	0.0-2.9	.32	.32	5	5	56
	7-20	20-35	1.40-1.75	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	20-60	20-32	1.45-1.75	0.20-1.98	0.12-0.19	3.0-5.9	.32	.32			
54B:											
Urban land------	---	---	---	---	---	---	---	---	-	---	---
Rousseau--------	0-6	0-10	1.30-1.55	5.95-19.98	0.07-0.09	0.0-2.9	.15	.15	5	1	250
	6-23	0-10	1.30-1.60	1.98-19.98	0.06-0.11	0.0-2.9	.15	.15			
	23-60	0-10	1.50-1.65	5.95-19.98	0.05-0.07	0.0-2.9	.15	.15			
55:											
Aquents---------	0-60	---	---	---	---	---	---	---	-	---	---
56:											
Dumps-----------	---	---	---	---	---	---	---	---	-	---	---
57A:											
Poseyville------	0-7	2-12	1.30-1.50	5.95-19.98	0.09-0.12	0.0-2.9	.17	.17	5	2	134
	7-22	12-18	1.55-1.70	0.57-1.98	0.06-0.14	0.0-2.9	.24	.24			
	22-60	18-35	1.45-1.70	0.20-1.98	0.12-0.19	3.0-5.9	.37	.37			
58A:											
Tappan----------	0-10	15-25	1.20-1.60	0.57-1.98	0.18-0.22	3.0-5.9	.28	.28	5	5	56
	10-29	18-30	1.60-1.80	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	29-60	15-30	1.60-1.80	0.06-0.20	0.15-0.19	3.0-5.9	.37	.37			
Poseyville------	0-7	2-12	1.30-1.50	5.95-19.98	0.09-0.12	0.0-2.9	.17	.17	5	2	134
	7-22	12-18	1.55-1.70	0.57-1.98	0.06-0.14	0.0-2.9	.24	.24			
	22-60	18-35	1.45-1.70	0.20-1.98	0.12-0.19	3.0-5.9	.37	.37			
59:											
Tobico----------	0-8	2-10	0.90-1.60	5.95-19.98	0.06-0.11	0.0-2.9	.15	.15	5	1	220
	8-60	0-10	1.45-1.70	19.98-19.98	0.04-0.07	0.0-2.9	.15	.15			
60:											
Essexville------	0-11	10-15	1.35-1.50	5.95-19.98	0.10-0.14	0.0-2.9	.17	.17	5	2	134
	11-26	2-12	1.40-1.55	5.95-19.98	0.04-0.12	0.0-2.9	.17	.17			
	26-60	10-35	1.45-1.65	0.20-0.57	0.12-0.20	0.0-2.9	.32	.32			
61:											
Cohoctah--------	0-11	5-20	1.20-1.50	1.98-5.95	0.13-0.22	0.0-2.9	.24	.24	5	3	86
	11-18	5-18	1.45-1.65	1.98-5.95	0.12-0.20	0.0-2.9	.28	.28			
	18-60	2-18	1.45-1.65	1.98-5.95	0.08-0.20	0.0-2.9	.28	.28			
62A:											
Sanilac---------	0-10	3-15	1.40-1.70	1.98-5.95	0.15-0.22	0.0-2.9	.37	.37	5	3	86
	10-42	0-18	1.45-1.80	0.20-1.98	0.06-0.22	0.0-2.9	.37	.37			
	42-60	0-18	1.50-1.90	0.20-1.98	0.06-0.22	0.0-2.9	.37	.37			

Physical Properties of Soils--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permea- bility (Ksat)	Available water capacity	Linear extensi- bility	Erosion factors K	Erosion factors Kf	Erosion factors T	Wind erodi- bility group	Wind erodi- bility index
	In	Pct	g/cc	in/hr	In/in	Pct					
Bach------------	0-13	2-15	1.30-1.60	1.98-5.95	0.20-0.22	0.0-2.9	.32	.32	5	3	86
	13-60	0-18	1.50-1.70	0.20-1.98	0.14-0.22	0.0-2.9	.43	.43			
63A:											
Rapson----------	0-9	2-15	1.35-1.70	5.95-19.98	0.06-0.12	0.0-2.9	.17	.17	5	2	134
	9-29	1-15	1.35-1.65	5.95-19.98	0.06-0.11	0.0-2.9	.17	.17			
	29-60	10-20	1.45-1.70	0.57-1.98	0.05-0.20	0.0-2.9	.43	.43			
Bach------------	0-13	2-15	1.30-1.60	1.98-5.95	0.20-0.22	0.0-2.9	.32	.32	5	3	86
	13-60	0-18	1.50-1.70	0.20-1.98	0.14-0.22	0.0-2.9	.43	.43			
64B:											
Londo-----------	0-7	5-18	1.40-1.70	1.98-5.95	0.14-0.18	0.0-2.9	.24	.24	5	3	86
	7-20	20-35	1.40-1.75	0.20-1.98	0.14-0.19	3.0-5.9	.32	.32			
	20-60	20-32	1.45-1.75	0.20-1.98	0.12-0.19	3.0-5.9	.32	.32			
Wixom-----------	0-9	2-12	1.20-1.60	5.95-19.98	0.10-0.12	0.0-2.9	.17	.17	5	2	134
	9-26	2-14	1.40-1.70	5.95-19.98	0.06-0.11	0.0-2.9	.15	.15			
	26-60	18-35	1.50-1.70	0.20-0.57	0.14-0.20	0.0-2.9	.43	.43			
65B:											
Geulph----------	0-8	12-20	1.40-1.65	0.57-1.98	0.14-0.16	0.0-2.9	.24	.24	5	3	86
	8-15	12-35	1.40-1.65	0.20-1.98	0.15-0.18	0.0-2.9	.28	.28			
	15-22	18-35	1.40-1.70	0.20-0.57	0.14-0.18	0.0-2.9	.32	.32			
	22-60	18-32	1.45-1.65	0.20-0.57	0.14-0.18	0.0-2.9	.32	.32			
Menominee-------	0-9	1-15	1.35-1.65	1.98-5.95	0.10-0.12	0.0-2.9	.17	.17	5	2	134
	9-33	1-15	1.30-1.70	5.95-19.98	0.04-0.10	0.0-2.9	.17	.24			
	33-60	18-35	1.45-1.70	0.20-0.57	0.14-0.18	3.0-5.9	.32	.32			
66A:											
Pipestone-------	0-4	2-12	1.30-1.50	5.95-19.98	0.07-0.10	0.0-2.9	.15	.15	5	1	220
	4-8	2-12	1.30-1.70	5.95-19.98	0.06-0.10	0.0-2.9	.15	.15			
	8-12	2-12	1.40-1.70	5.95-19.98	0.06-0.09	0.0-2.9	.15	.15			
	12-60	2-12	1.40-1.65	5.95-19.98	0.05-0.07	0.0-2.9	.15	.15			
Tobico----------	0-8	2-10	0.90-1.60	5.95-19.98	0.06-0.11	0.0-2.9	.15	.15	5	1	220
	8-60	0-10	1.45-1.70	19.98-19.98	0.04-0.07	0.0-2.9	.15	.15			
67:											
Belleville------	0-11	2-12	1.35-1.50	5.95-19.98	0.10-0.12	0.0-2.9	.17	.17	4	8	0
	11-36	2-15	1.40-1.55	5.95-19.98	0.06-0.10	0.0-2.9	.17	.17			
	36-60	18-35	1.46-1.80	0.20-0.57	0.14-0.20	3.0-5.9	.32	.32			
68:											
Cohoctah--------	0-11	0-15	1.20-1.50	5.95-19.98	0.10-0.15	0.0-2.9	.17	.17	4	3	86
	11-18	5-18	1.45-1.65	1.98-5.95	0.12-0.20	0.0-2.9	.28	.28			
	18-60	2-18	1.45-1.65	1.98-5.95	0.08-0.20	0.0-2.9	.28	.28			
W:											
Water-----------	---	---	---	---	---	---	---	---	-	---	---

Physical Properties of Soils--Continued

ENDNOTE--PHYSICAL PROPERTIES OF SOILS

The above table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

CLAY as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

MOIST BULK DENSITY is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar(33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. The estimatred moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influence by texture, kind of clay, content of organic matter, and soil structure.

PERMEABILITY(Ksat) refers to the ability of a soil to transmit water or air. The term permeability, as used in soil surveys, indicates saturated hydraulic conductivity (Ksat). The estimates in the table indicate the rate of water movement, in inches per hour, when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

AVAILABLE WATER CAPACITY refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irritation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

LINEAR EXTENSIBILITY refers to the change in length of an unconfined clod as moisture contest is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension(33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. Volume change is influenced by the amount and type of clay minerals in the soil. Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

EROSION FACTORS are shown as the K factor (K and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of several factors used in the Universal Soil Loss Equation (USLE) sand the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand , and organic matter and on soil structure and permeability. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

EROSION FACTOR K indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

EROSION FACTOR Kf indicates the erodibility of the fine-earth, or the material less than 2 millimeters in size.

EROSION FACTOR T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

WIND ERODIBILITY GROUPS are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material and sapric soil material.

3. Coarse sandy loams, sandy loams, find sandy loams, and very fine sandy loams.

Physical Properties of Soils--Continued

4L. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcereous clay loams that are less than 35 percent clay.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.

8. Soils that are not subject to wind erosion because of rock fragments on the surface or because of surface wetness.

WIND ERODIBILITY INDEX is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

24-Hour Rainfall in Michigan (inches)						
County	2-year	5-year	10-year	25-year	50-year	100-year
ALCONA	2.33	2.86	3.25	3.75	4.17	4.62
ALGER	2.30	2.68	3.00	3.50	4.00	4.50
ALLEGAN	2.67	3.45	3.95	4.50	5.25	5.87
ALPENA	2.30	2.80	3.17	3.68	4.13	4.56
ANTRIM	2.36	2.85	3.20	3.75	4.13	4.56
ARENAC	2.41	2.96	3.35	3.87	4.33	4.81
BARAGA	2.44	2.92	3.30	3.80	4.25	4.68
BARRY	2.60	3.25	3.70	4.37	4.87	5.43
BAY	2.43	2.98	3.37	3.87	4.37	4.90
BENZIE	2.45	3.00	3.40	3.95	4.43	4.87
BERRIEN	2.80	3.58	4.00	4.50	5.50	6.00
BRANCH	2.58	3.17	3.62	4.25	4.75	5.20
CALHOUN	2.57	3.15	3.60	4.25	4.75	5.12
CASS	2.73	3.47	4.00	4.50	5.25	5.87
CHARLEVOIX	2.31	2.77	3.12	3.62	4.00	4.50
CHEBOYGAN	2.26	2.72	3.05	3.56	4.00	4.50
CHIPPEWA	2.20	2.60	3.00	3.50	4.00	4.50
CLARE	2.48	3.07	3.50	4.12	4.56	5.00
CLINTON	2.51	3.05	3.45	4.00	4.50	4.96
CRAWFORD	2.40	2.92	3.30	3.87	4.31	4.70
DELTA	2.36	2.77	3.05	3.50	4.00	4.50
DICKINSON	2.45	2.90	3.25	3.68	4.13	4.50
EATON	2.55	3.10	3.50	4.12	4.62	5.00
EMMET	2.26	2.72	3.05	3.50	4.00	4.50
GENESEE	2.40	2.92	3.32	3.78	4.28	4.78
GLADWIN	2.45	3.02	3.40	3.96	4.43	4.90
GOGEBIC	2.57	3.15	3.60	4.25	4.69	5.20
GRAND TRAVERSE	2.42	2.97	3.36	3.93	4.38	4.81
GRATIOT	2.51	3.05	3.47	4.06	4.50	4.96
HILLSDALE	2.54	3.05	3.45	4.00	4.48	4.96
HOUGHTON	2.40	2.92	3.35	3.87	4.30	4.80
HURON	2.32	2.87	3.27	3.65	4.16	4.65
INGHAM	2.50	2.98	3.38	3.95	4.43	4.90
IONIA	2.56	3.17	3.60	4.25	4.75	5.25
IOSCO	2.37	2.90	3.30	3.78	4.28	4.70
IRON	2.49	3.00	3.37	3.87	4.30	4.77
ISABELLA	2.51	3.12	3.55	4.15	4.62	5.10
JACKSON	2.51	2.98	3.38	3.95	4.43	4.93
KALAMAZOO	2.65	3.33	3.85	4.50	5.06	5.62
KALKASKA	2.41	2.95	3.32	3.90	4.31	4.75
KENT	2.62	3.30	3.80	4.50	5.06	5.62
KEWEENAW	2.35	2.82	3.25	3.68	4.13	4.58
LAKE	2.53	3.20	3.65	4.31	4.81	5.37
LAPEER	2.35	2.88	3.28	3.68	4.19	4.68
LEELANAU	2.38	2.90	3.25	3.81	4.18	4.62
LENAWEE	2.50	2.97	3.36	3.87	4.37	4.83
LIVINGSTON	2.46	2.95	3.34	3.83	4.33	4.81
LUCE	2.20	2.60	3.00	3.50	4.00	4.50
MACKINAC	2.20	2.62	3.00	3.50	4.00	4.50

MACOMB	2.32	2.85	3.25	3.62	4.10	4.61
MANISTEE	2.50	3.10	3.50	4.12	4.62	5.12
MARQUETTE	2.40	2.82	3.15	3.62	4.00	4.50
MASON	2.55	3.25	3.70	4.37	4.93	5.50
MECOSTA	2.55	3.20	3.65	4.31	4.81	5.31
MENOMINEE	2.45	2.90	3.20	3.68	4.13	4.50
MIDLAND	2.47	3.03	3.43	3.96	4.46	4.93
MISSAUKEE	2.45	3.10	3.45	4.00	4.50	4.93
MONROE	2.43	2.92	3.30	3.77	4.23	4.73
MONTCALM	2.56	3.17	3.65	4.25	4.75	5.25
MONTMORENCY	2.32	2.82	3.17	3.71	4.13	4.56
MUSKEGON	2.65	3.40	3.95	4.50	5.25	5.87
NEWAYGO	2.60	3.30	3.80	4.50	5.00	5.60
OAKLAND	2.37	2.88	3.28	3.71	4.22	4.70
OCEANA	2.60	3.32	3.85	4.50	5.13	5.75
OGEMAW	2.42	2.95	3.35	3.87	4.37	4.78
ONTONAGON	2.51	3.70	3.50	4.12	4.56	5.10
OSCEOLA	2.51	3.15	3.55	4.22	4.73	5.18
OSCODA	2.37	2.90	3.27	3.81	4.25	4.68
OTSEGO	2.33	2.83	3.20	3.75	4.13	4.50
OTTAWA	2.67	3.43	3.95	4.50	5.31	5.87
PRESQUE ISLE	2.26	2.75	3.10	3.62	4.00	4.50
ROSCOMMON	2.43	3.00	3.37	3.96	4.43	4.87
SAGINAW	2.45	2.97	3.37	3.87	4.37	4.87
SANILAC	2.31	2.85	3.25	3.62	4.13	4.62
SCHOOLCRAFT	2.27	2.67	3.00	3.50	4.00	4.50
SHIAWASSEE	2.46	2.97	3.37	3.90	4.37	4.87
ST CLAIR	2.30	2.83	3.23	3.56	4.06	4.56
ST JOSEPH	2.66	3.32	3.82	4.50	5.04	5.50
TUSCOLA	2.37	2.91	3.31	3.71	4.25	4.71
VAN BUREN	2.73	3.47	4.00	4.50	5.35	5.87
WASHTENAW	2.45	2.93	3.33	3.83	4.31	4.81
WAYNE	2.37	2.86	3.27	3.65	4.19	4.68
WEXFORD	2.47	3.10	3.50	4.06	4.56	5.00

Monthly Rainfall by County for Michigan
(inches)

County	Jan_P	Feb_P	Mar_P	Apr_P	May_P	Jun_P	Jul_P	Aug_P	Sep_P	Oct_P	Nov_P	Dec_P	Annual
Alcona	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Alger	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Allegan	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Alpena	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Antrim	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Arenac	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39
Baraga	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Barry	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Bay	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39
Benzie	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Berrien	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Branch	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Calhoun	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Cass	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Charlevoix	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Cheboygar	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Chippewa	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Clare	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Clinton	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Crawford	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Delta	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Dickinson	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Eaton	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Emmet	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Genesee	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Gladwin	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Gogebic	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Grand Trav	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Gratiot	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Hillsdale	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Houghton	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Huron	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39
Ingham	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Ionia	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Iosco	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Iron	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77

Monthly Rainfall by County for Michigan
(inches)

Isabella	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Jackson	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Kalamazoo	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Kalkaska	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Kent	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Keweenaw	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Lake	2.22	1.62	2.3	3.14	2.71	2.9	2.71	3.62	3.57	3.16	3.1	2.55	33.6
Lapeer	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Leelanau	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Lenawee	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Livingston	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Luce	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Mackinac	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Macomb	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Manistee	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Marquette	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Mason	2.22	1.62	2.3	3.14	2.71	2.9	2.71	3.62	3.57	3.16	3.1	2.55	33.6
Mecosta	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Menominee	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Midland	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Missaukee	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35
Monroe	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Montcalm	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Montmorer	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Muskegon	2.22	1.62	2.3	3.14	2.71	2.9	2.71	3.62	3.57	3.16	3.1	2.55	33.6
Newaygo	2.22	1.62	2.3	3.14	2.71	2.9	2.71	3.62	3.57	3.16	3.1	2.55	33.6
Oakland	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Oceana	2.22	1.62	2.3	3.14	2.71	2.9	2.71	3.62	3.57	3.16	3.1	2.55	33.6
Ogemaw	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Ontonagon	1.86	1.35	2	2.4	3.25	3.62	3.39	3.78	3.61	2.81	2.62	2.08	32.77
Osceola	1.65	1.34	2.15	2.98	2.86	3.15	2.76	3.57	3.66	2.68	2.59	2.14	31.53
Oscoda	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Otsego	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Ottawa	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Presque Is	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Roscommo	1.63	1.32	1.89	2.47	2.75	2.89	3.04	3.34	3.49	2.49	2.43	1.97	29.71
Saginaw	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39

Monthly Rainfall by County for Michigan
(inches)

St Clair	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
St Joseph	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Sanilac	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39
Schoolcraf	2.02	1.48	1.97	2.36	2.8	3.19	3.05	3.53	3.68	2.83	2.87	2.33	32.11
Shiawasse	1.7	1.53	2.3	3.19	3.04	3.58	3.28	3.36	3.24	2.53	2.58	2.2	32.53
Tuscola	1.67	1.46	2.17	2.7	2.67	3.06	2.78	3.17	3.52	2.55	2.54	2.1	30.39
Van Buren	2.21	1.67	2.48	3.53	3.14	3.56	3.39	3.33	3.64	2.96	3.03	2.78	35.72
Washtenav	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Wayne	1.73	1.66	2.38	3.08	2.82	3.35	3.03	3.23	2.88	2.37	2.64	2.32	31.49
Wexford	1.94	1.41	1.87	2.69	2.58	2.94	2.86	3.3	3.83	2.91	2.79	2.23	31.35

A-F CN = 78 P = 3.37 (10-yr)

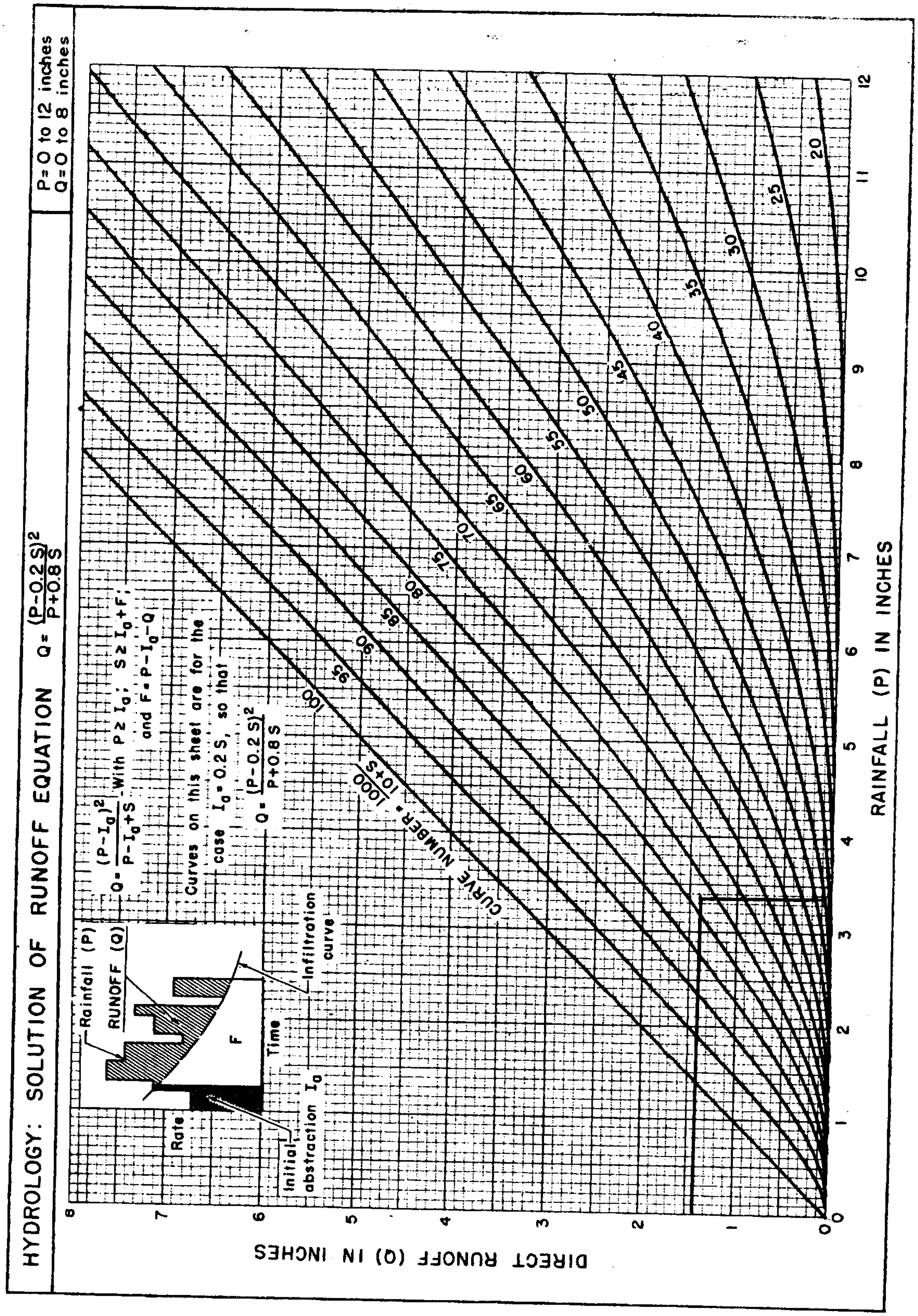


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 1.4 inches

A-F CN = 78 P = 3.87 (25-yr)

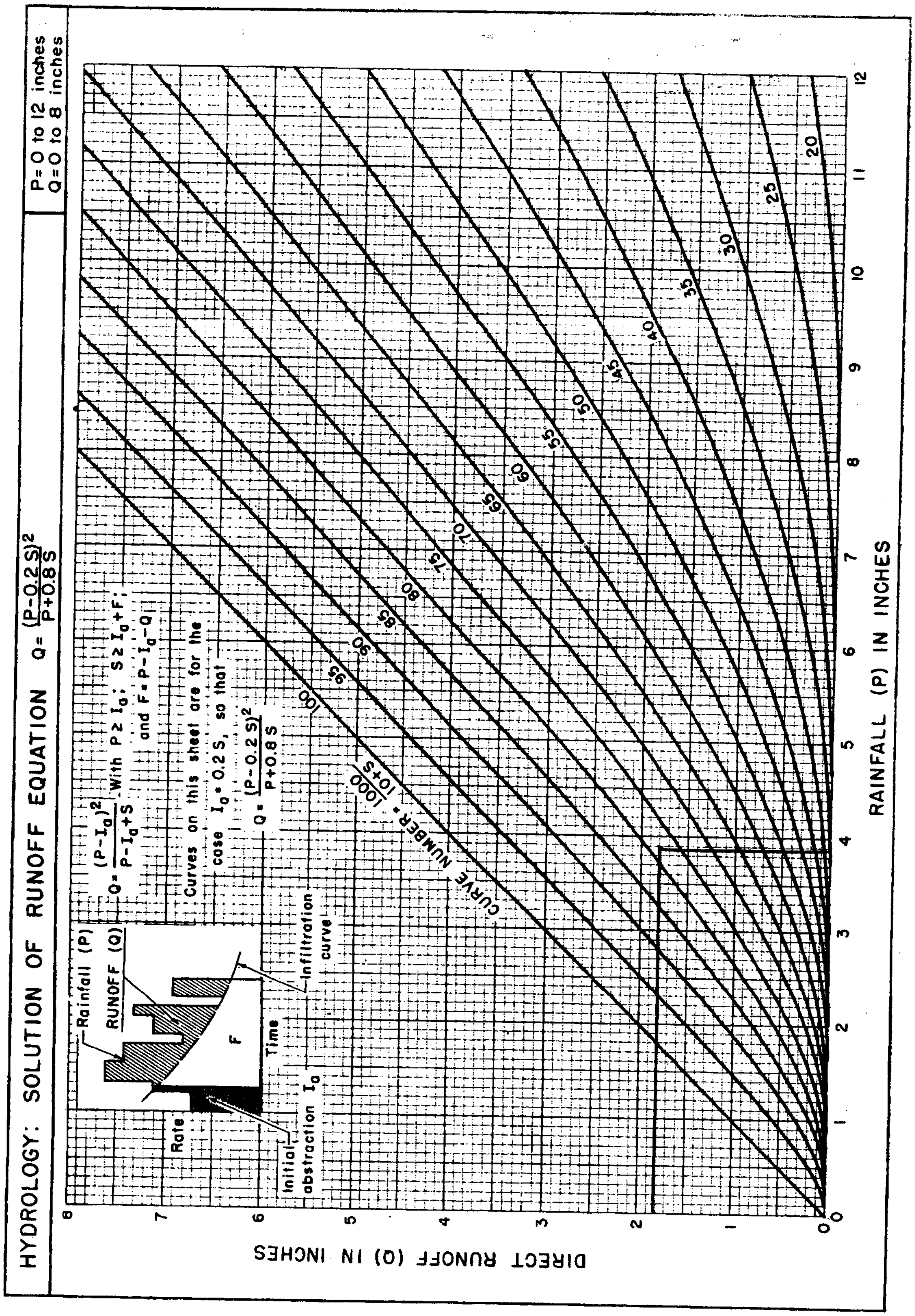


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 1.8 inches

A-F CN = 78 P = 4.37 (50-yr)

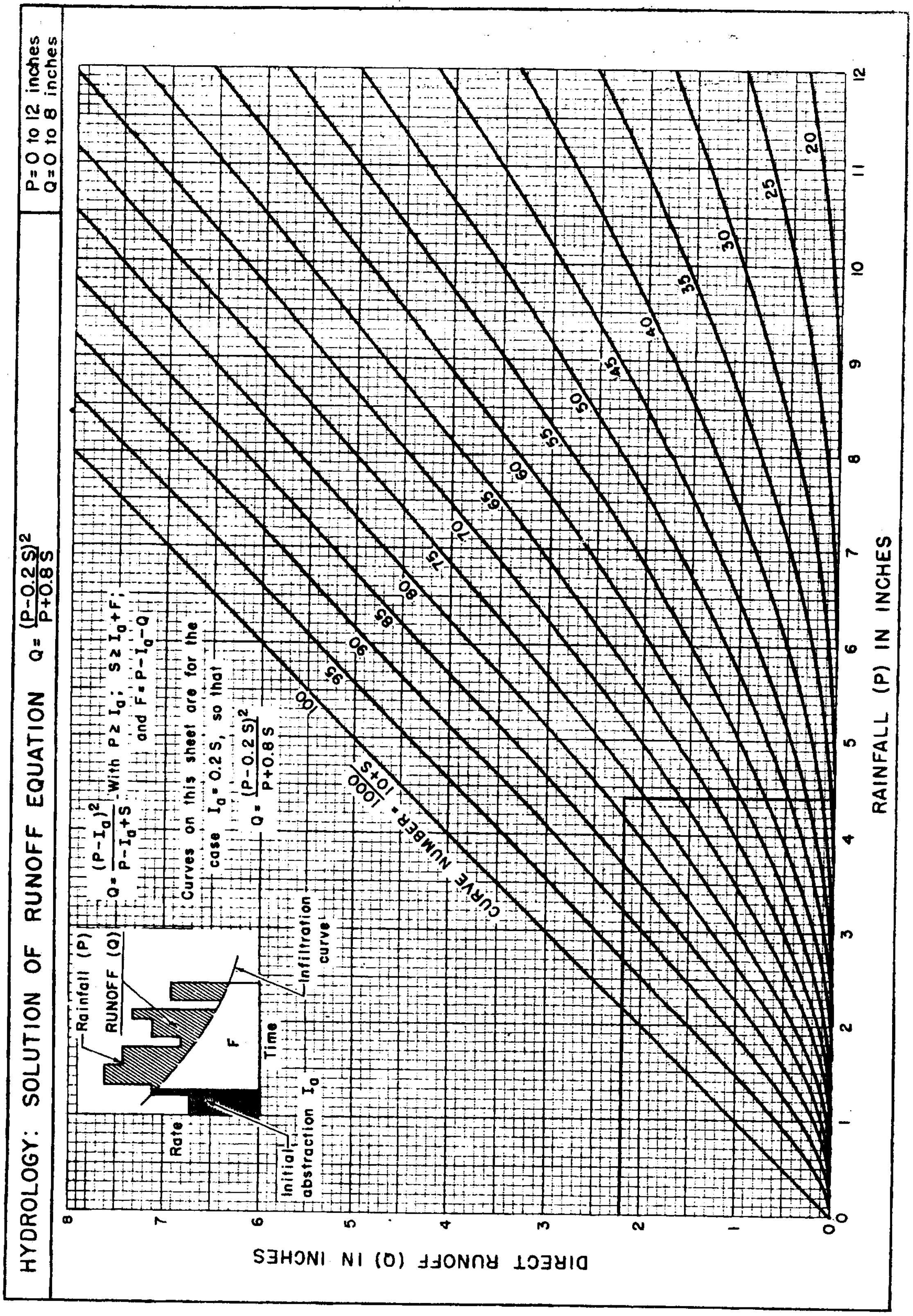


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 2.2 inches

A-F CN = 78 P = 4.90 (100-yr)

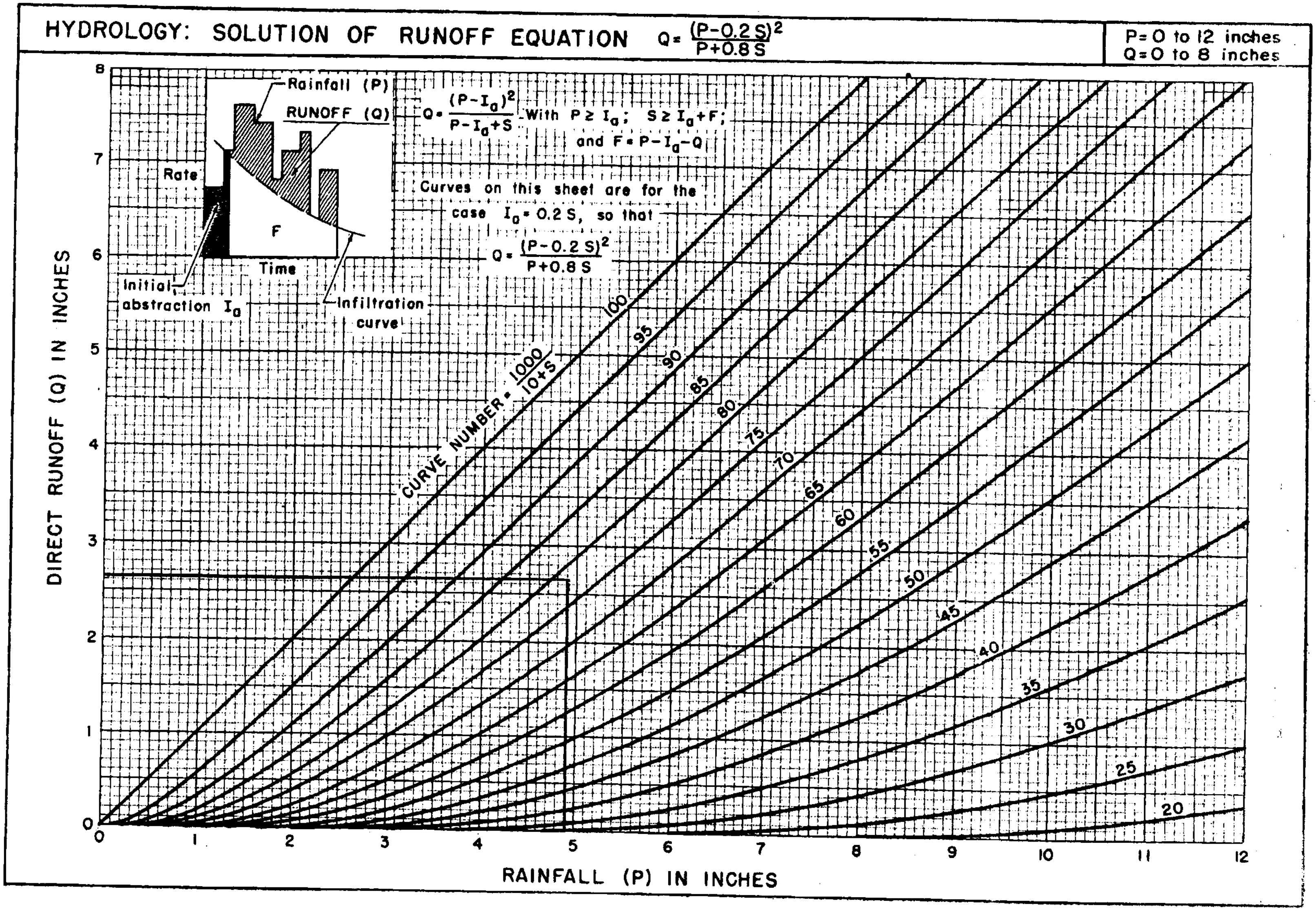


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 2.65 inches

G CN = 55 P = 3.37 (10-yr)

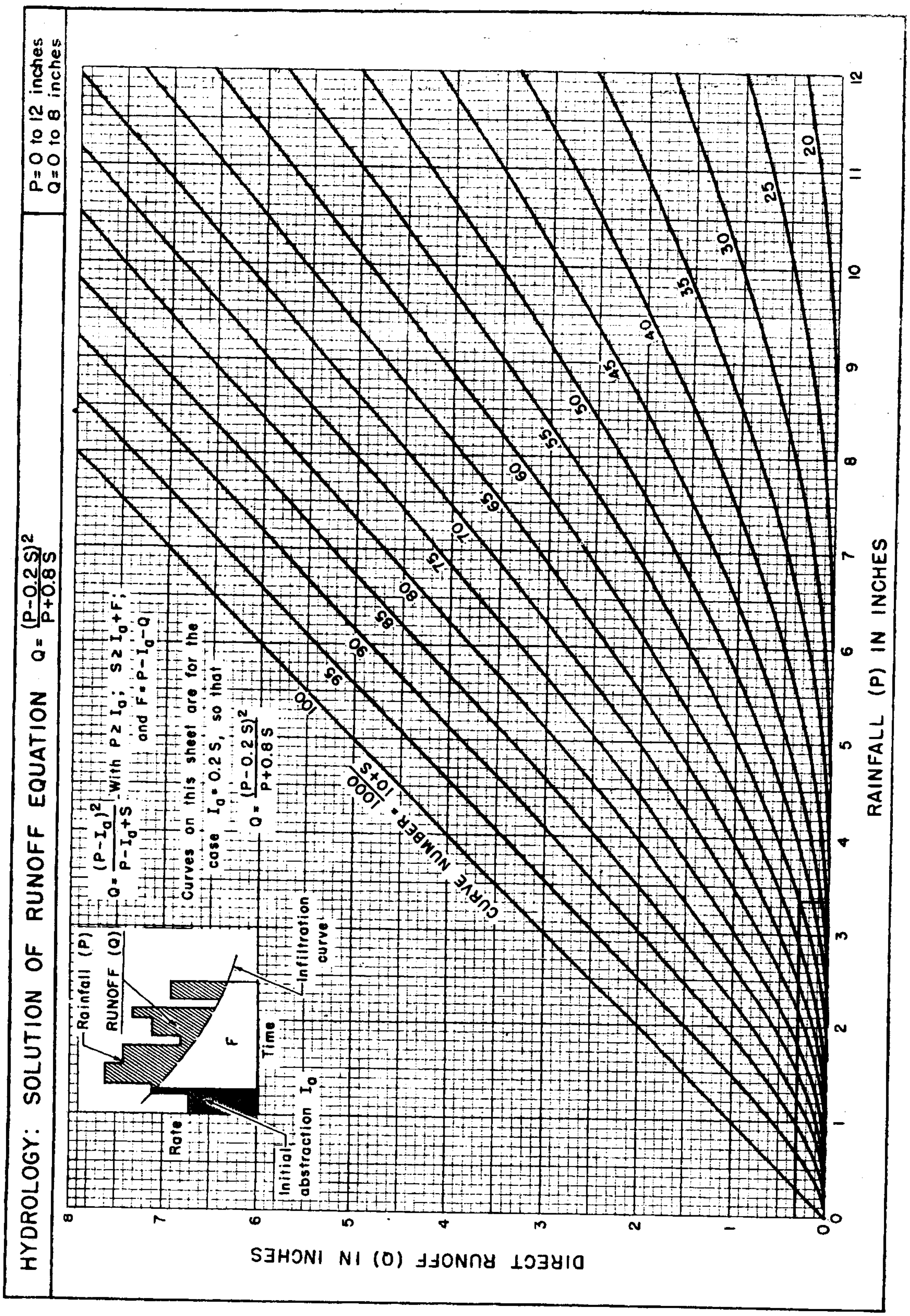


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 0.3 inches

G CN = 55 P = 3.87

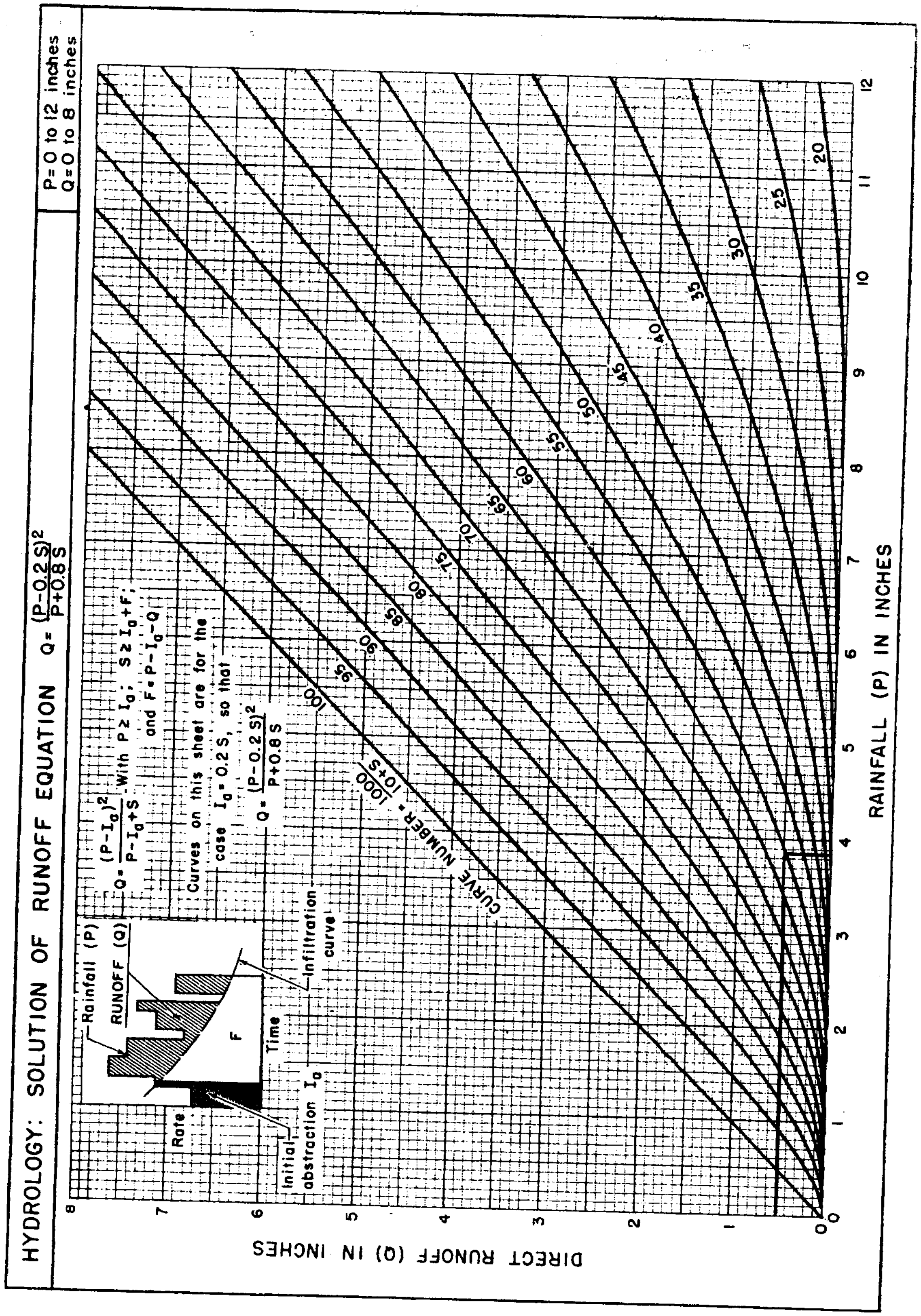


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 0.5 inches

G CN = 55 P = 4.37

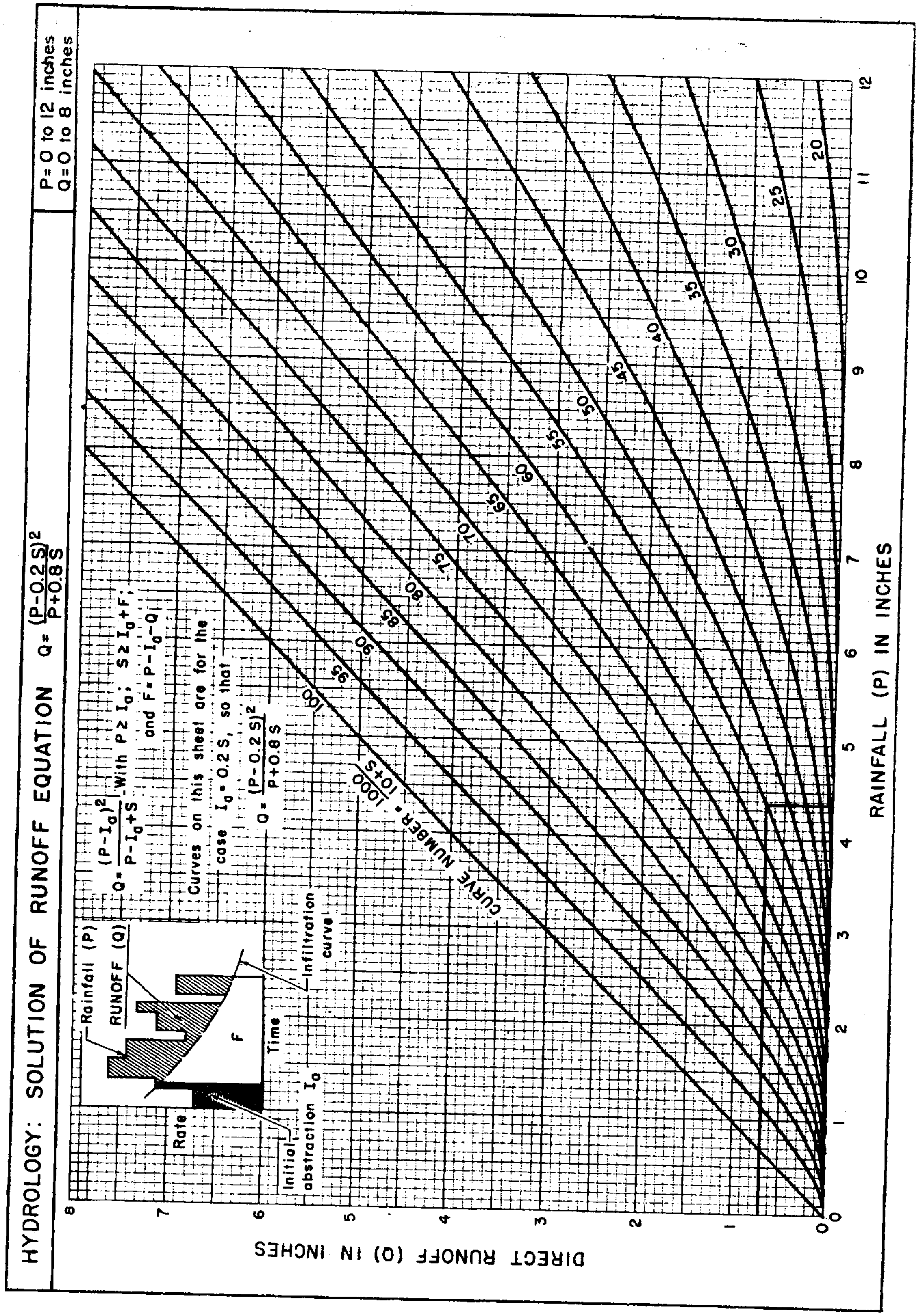


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 0.7 inches

G

CN = 55 P= 4.9

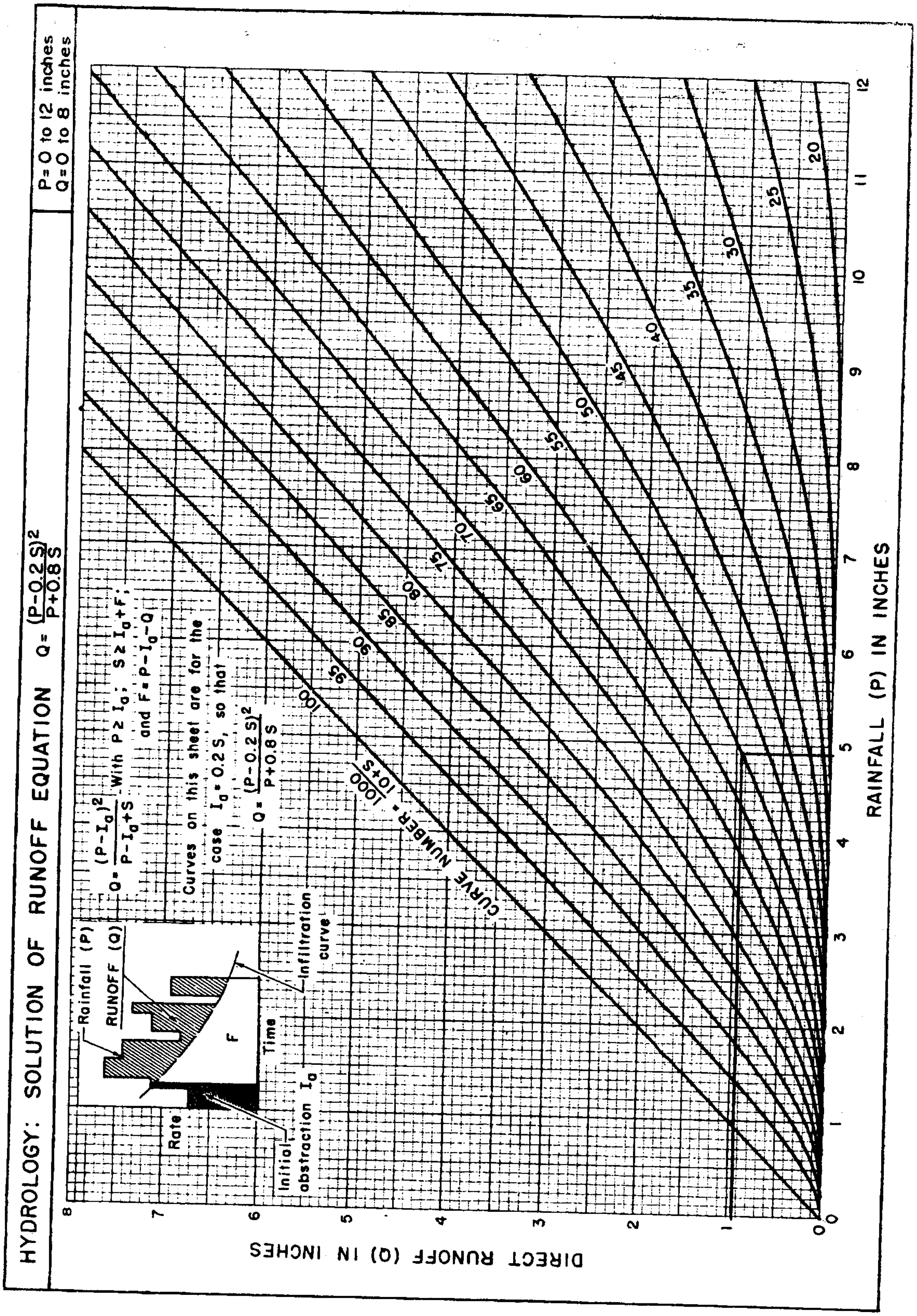


Figure 3.--Solution of the runoff equation, $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$

Q = 0.95 inches

A $\ell = 6938$ Y= 1% CN = 78

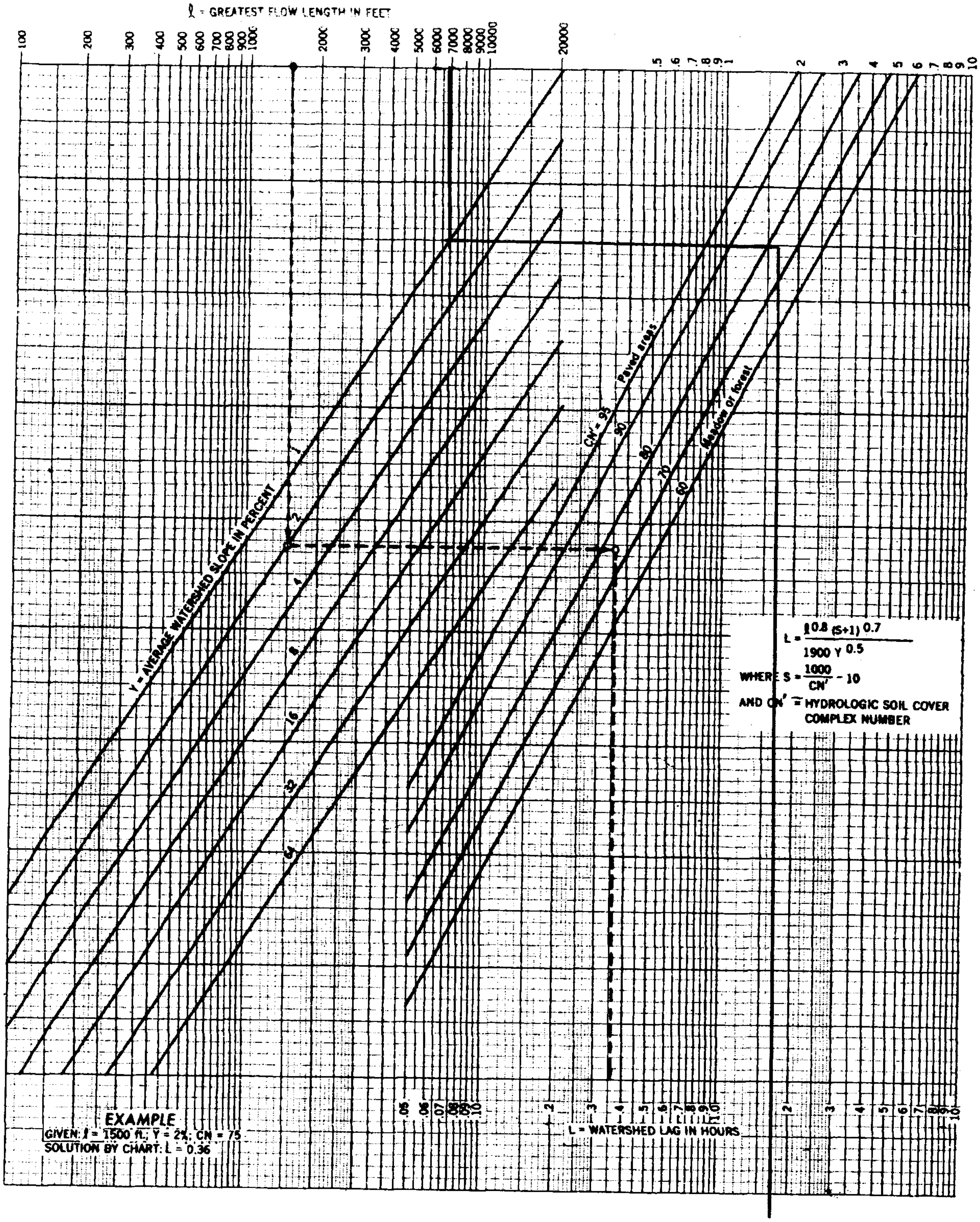
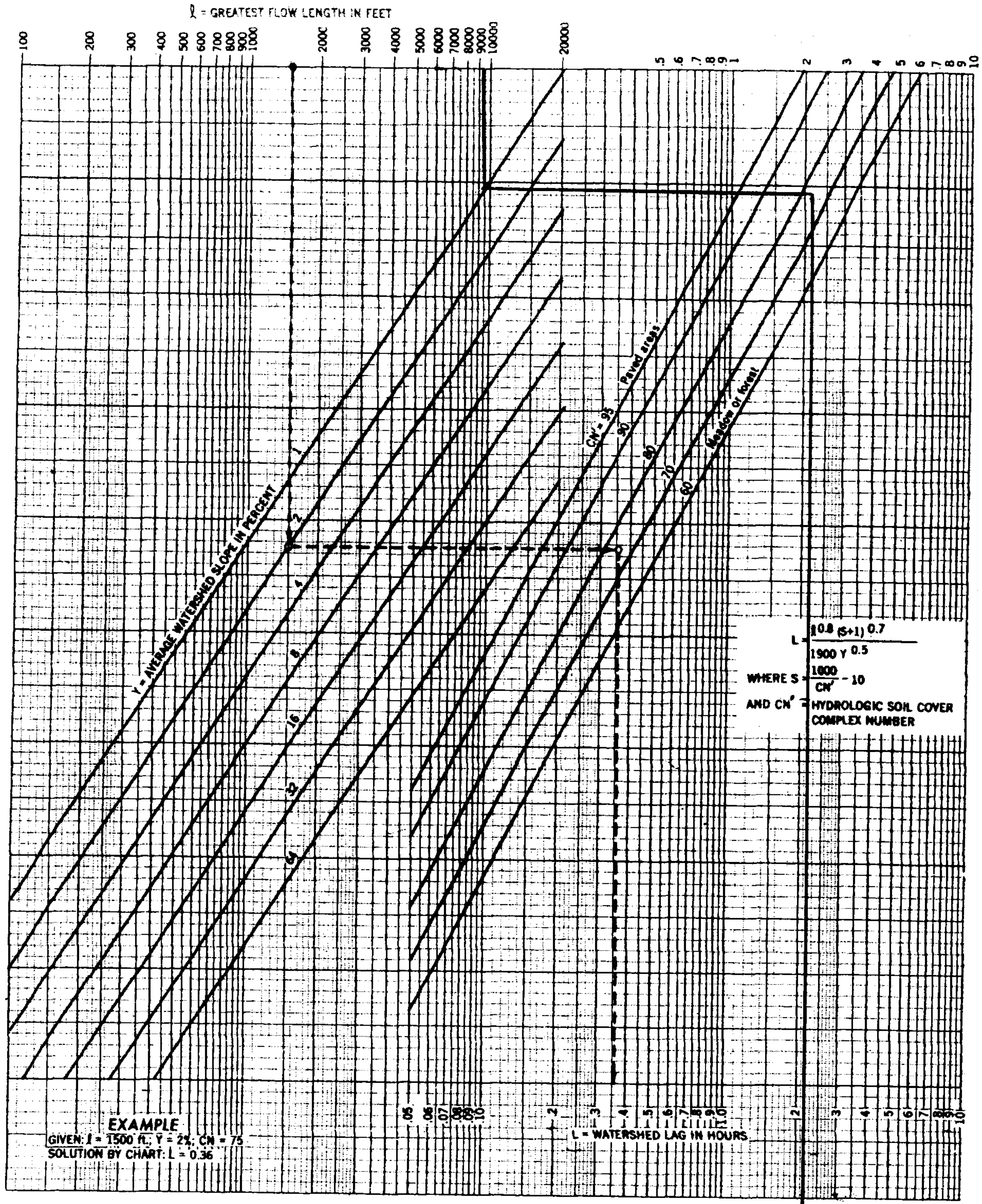


Figure 6.--Watershed lag (NEH-4 January 1971).

L = 1.7 hrs

B $\ell = 9377$ $Y = 1\%$ CN = 78



$$L = \frac{\ell^{0.8}(S+1)^{0.7}}{1900\,Y^{0.5}}$$

WHERE $S = \frac{1000}{CN'} - 10$

AND CN' = HYDROLOGIC SOIL COVER COMPLEX NUMBER

Figure 6.--Watershed lag (NEH-4 January 1971).

L = 2.15 hrs

C $l = 7270$ $Y = 1\%$ CN = 78

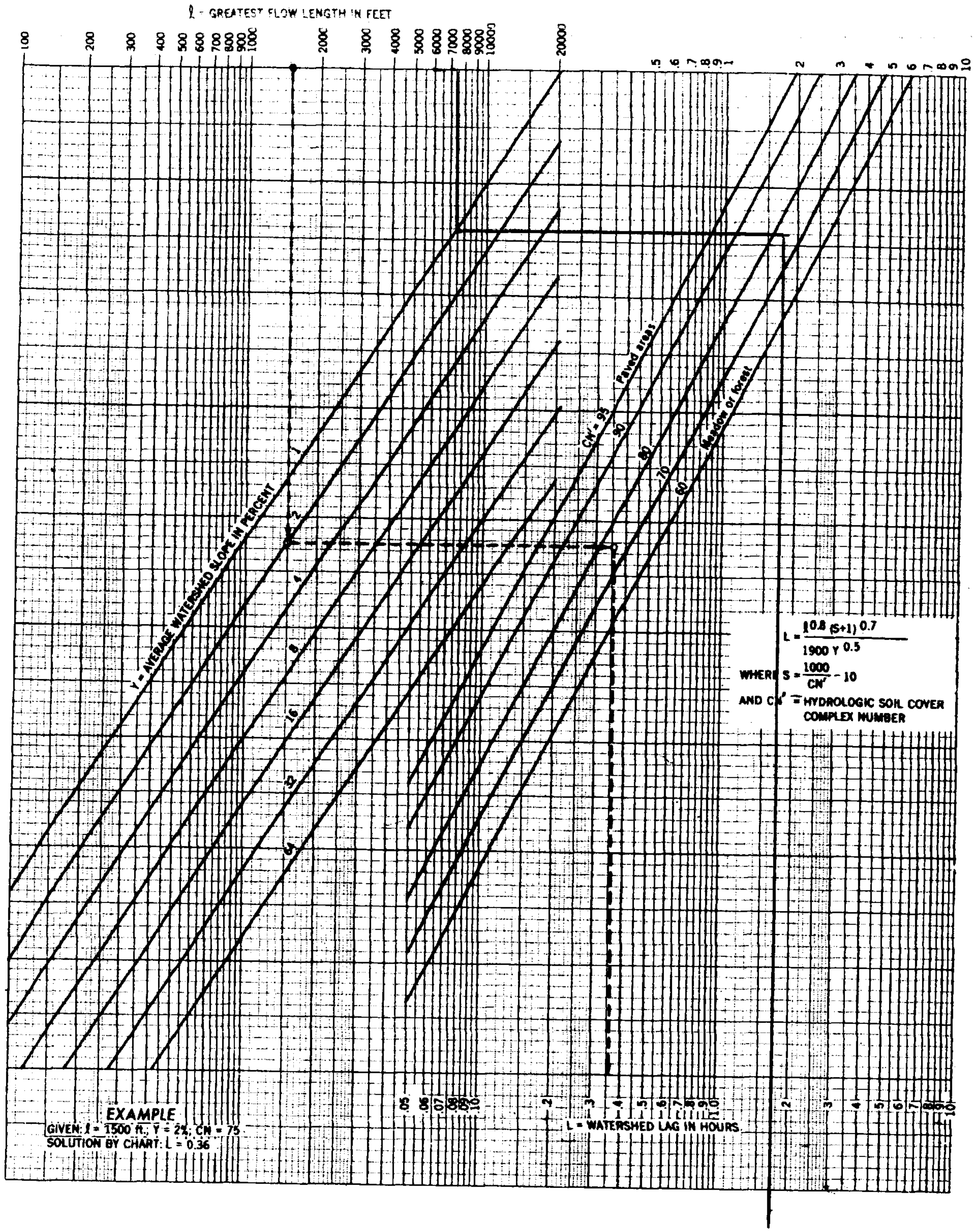


Figure 6.--Watershed lag (NEH-4 January 1971).

L = 1.7 hr

D ℓ = 7624 Y = 1% CN = 78

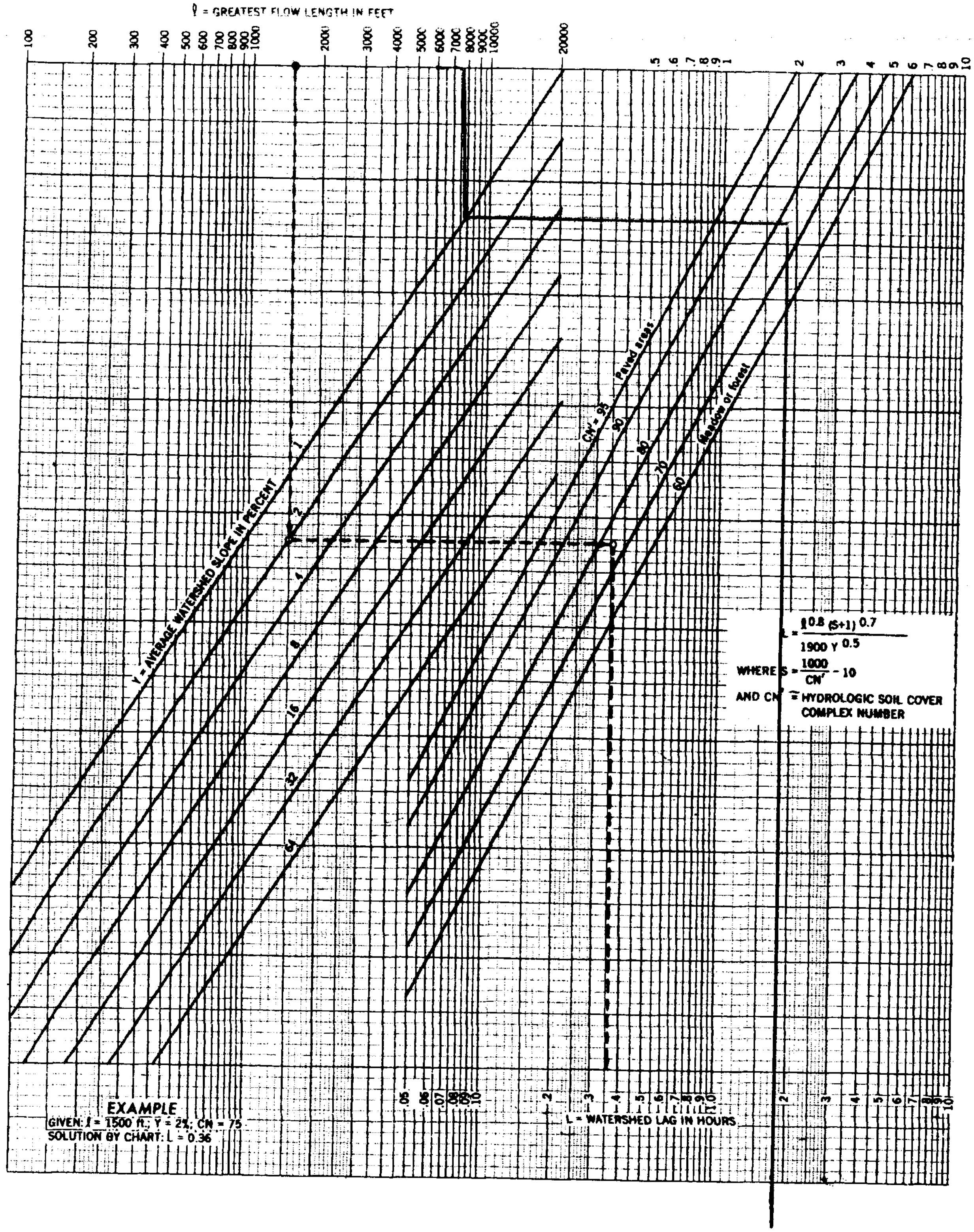


Figure 6.--Watershed lag (NEH-4 January 1971).

L = 1.8 hrs

E $l = 10515$ $Y = 190$ $CN = 78$

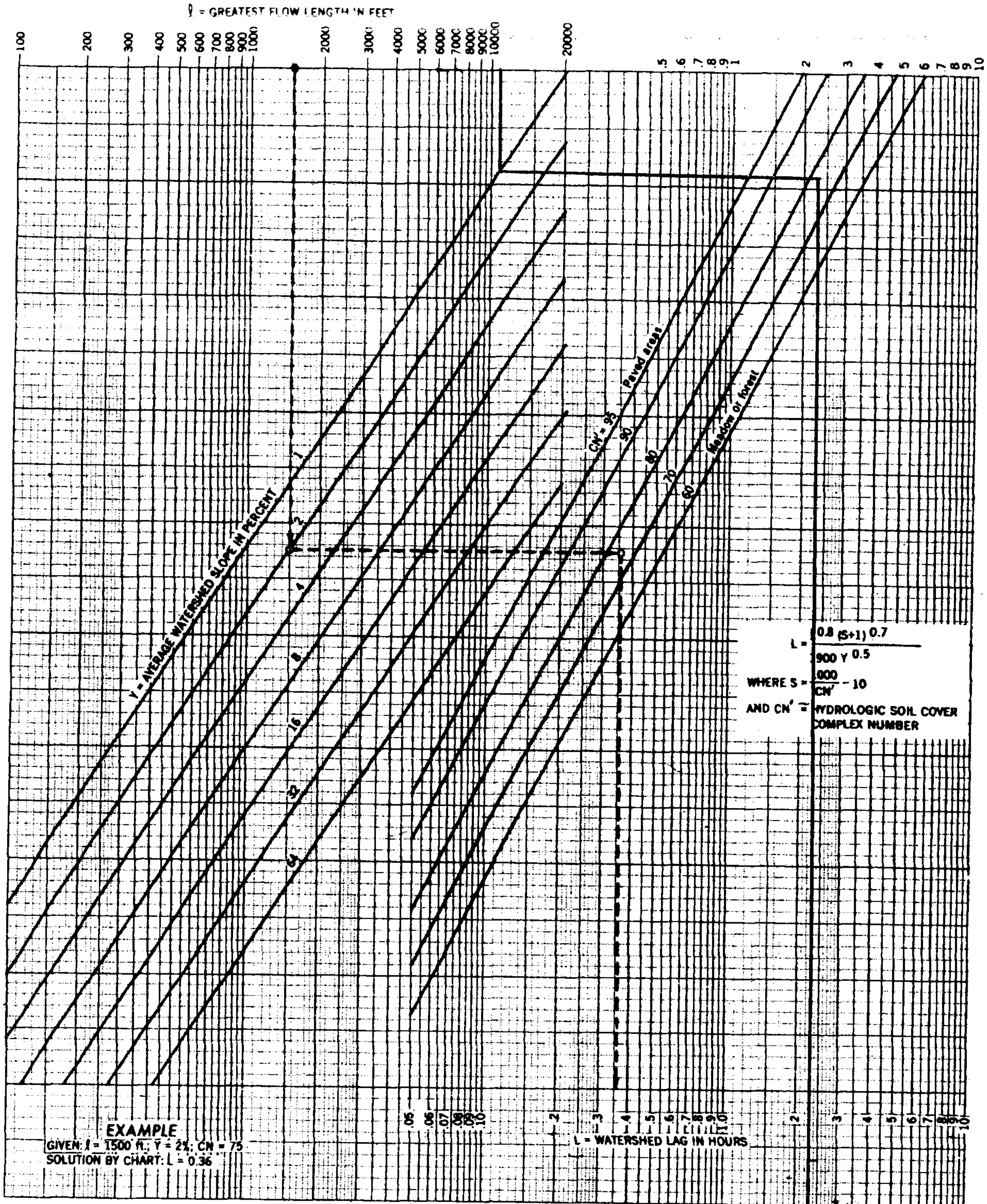


Figure 6.--Watershed lag (NEH-4 January 1971).

$L = 2.3$ hrs

F ℓ = 8637 Y = 1 % CN = 78

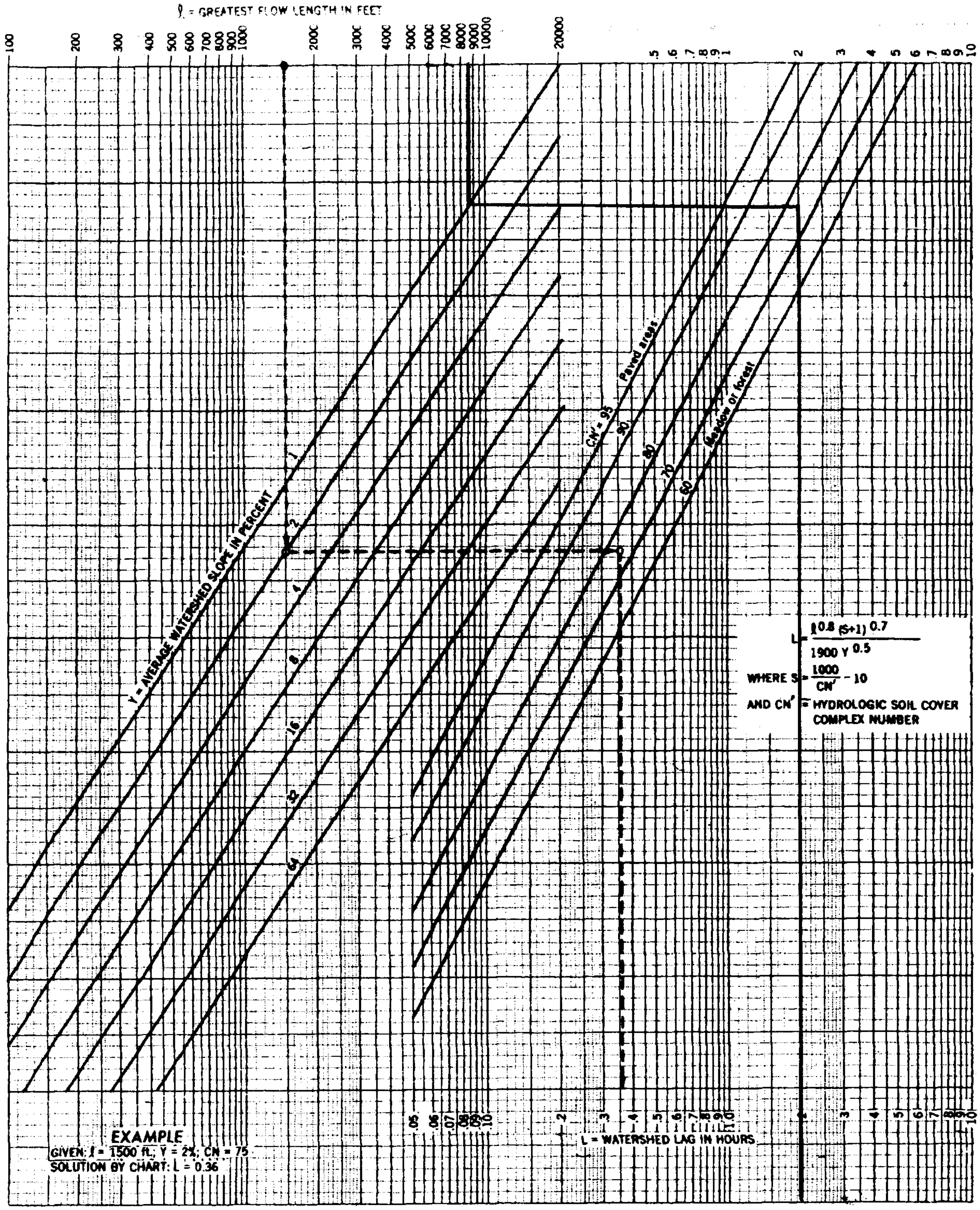


Figure 6.--Watershed lag (NEH-4 January 1971).

L = 2 hrs

G   ℓ= 12077   Y= 1%   CN= 55

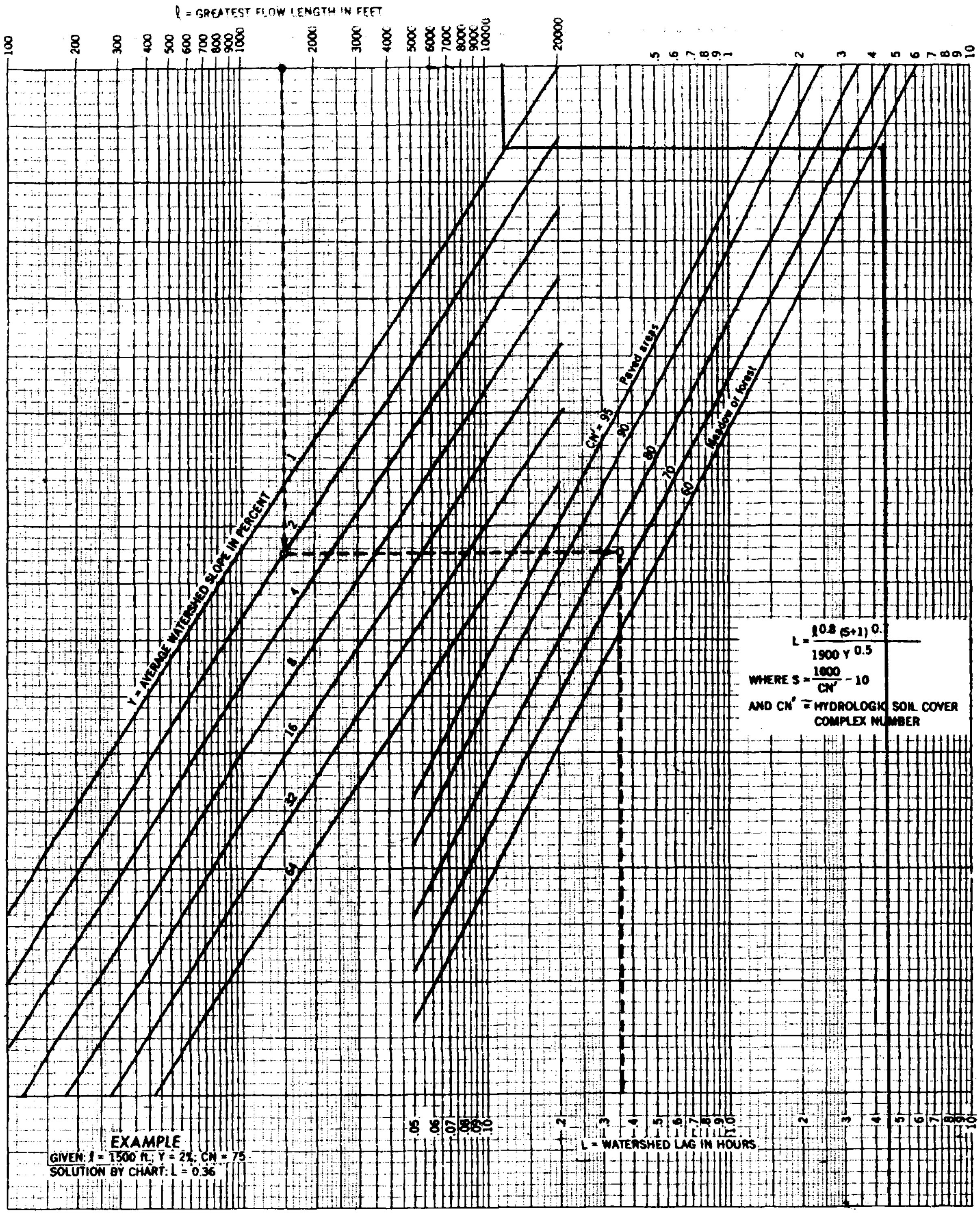


Figure 6.--Watershed lag (NEH-4 January 1971).

L= 4.5 hrs

H $l = 12360$ $Y = 1\%$ CN = 100

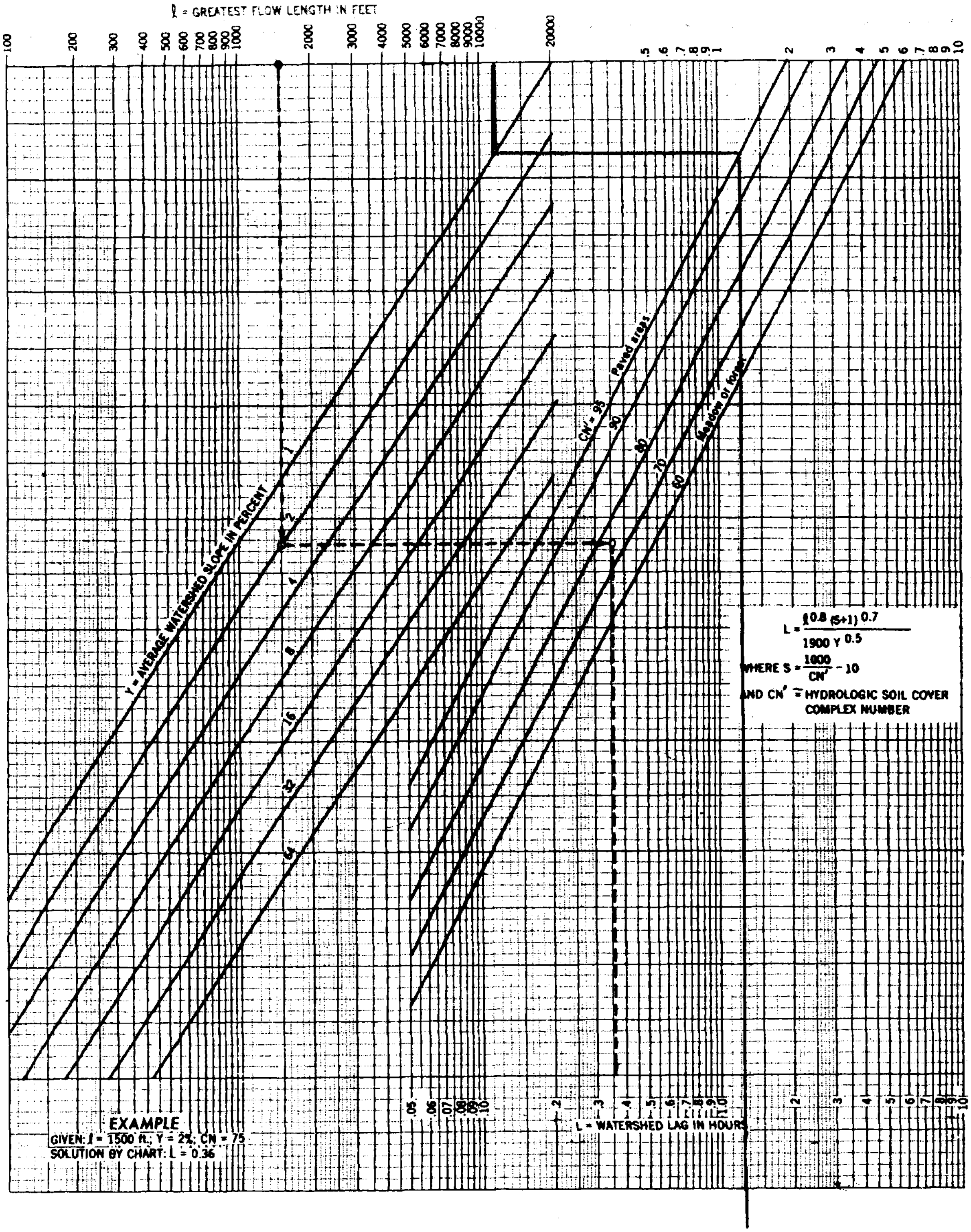


Figure 6.--Watershed lag (NEH-4 January 1971).

L = 1.25 hrs

TOBICO MARSH WATERSHED
HYDROLOGIC CALCULATIONS SUMMARY
SAGINAW BAY, MICHIGAN

	Subwatershed	*Catchment Area (acres)*	*Catchment Area (square miles)*	*Soil Group*	*Primary Land Use*	*Treatment Class*	*Hydrologic Condition*	*Runoff Curve Number*
A	Hadd Drain	342.9	0.54	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
B	Dubay Drain	566.5	0.89	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
C	Wetters Drain	370.7	0.58	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
D	Tobico Drain	401.2	0.63	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
E	Lesperance Drain	685.6	1.07	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
F	Van Alstine Drain	494.0	0.77	B	Agricultural	Row Crops, Straight Row, Lightly Grazed	Good	78
G	Tobico Marsh State Game A	863.7	1.35	B	Woods, Forest	Protected from Grazing	Good	55
H	Tobico Marsh	897.7	1.40	B	Marsh	Water Surface	n/a	100

Lag was calculated using the curve number method

TOBICO MARSH WATERSHED
HYDROLOGIC CALCULATIONS SUMMARY
SAGINAW BAY, MICHIGAN

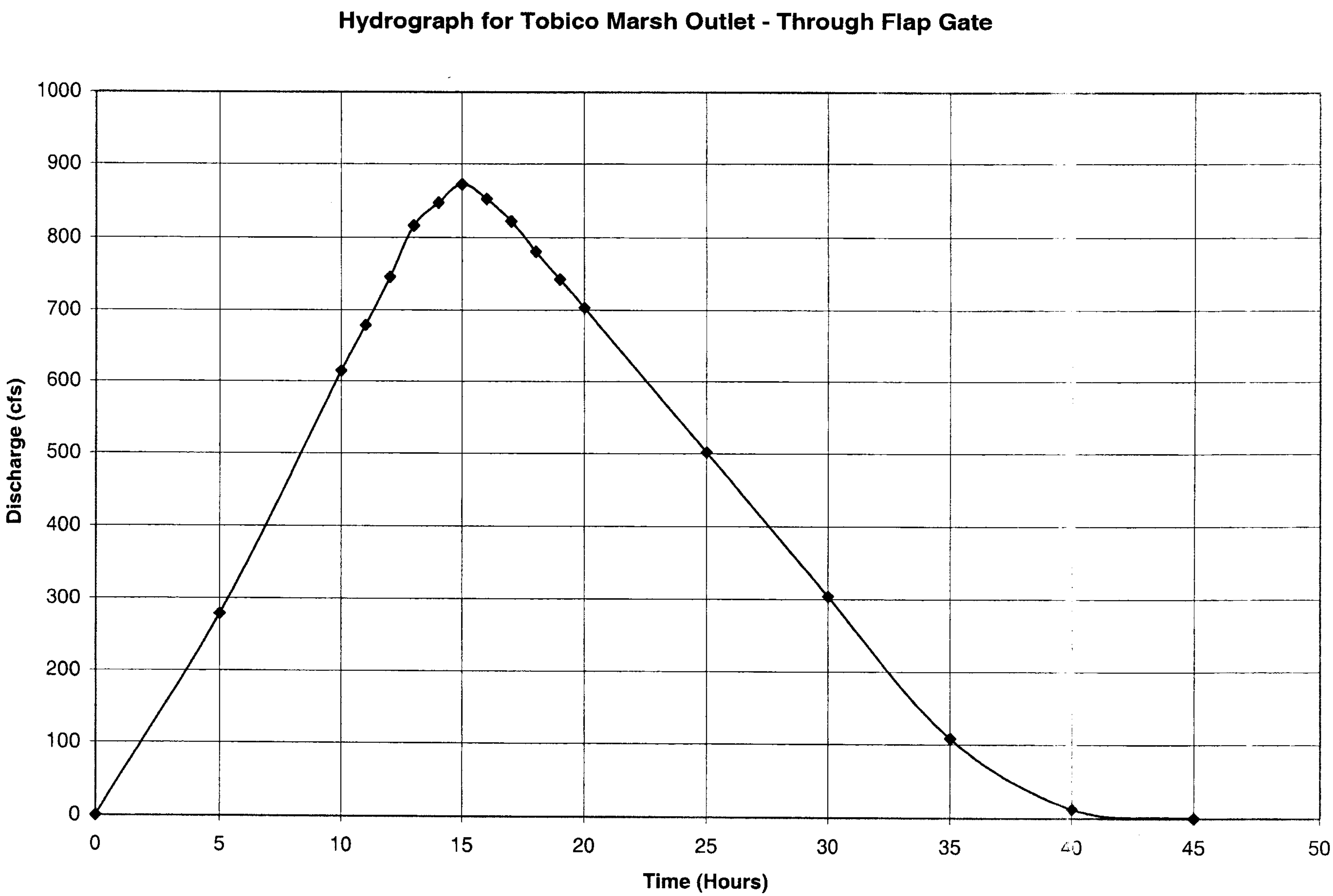
	Subwatershed	24-hour Rainfall in Bay County, Michigan 10-year 3.37	25-year 3.87	50-year 4.37	100-year 4.9	Hydraulic Length (feet)	Watershed Parameters Average Slope (% slope)	Lag (hours)	Tc (hours)	Lag to Marsh Outlet (hours)
		Direct Runoff (inches)								
A	Hadd Drain	1.4	1.8	2.2	2.65	6938	1.0%	1.7	2.8	2.2
B	Dubay Drain	1.4	1.8	2.2	2.65	9377	1.0%	2.2	3.6	1.9
C	Wetters Drain	1.4	1.8	2.2	2.65	7270	1.0%	1.7	2.8	1.5
D	Tobico Drain	1.4	1.8	2.2	2.65	7624	1.0%	1.8	3.0	1.1
E	Lesperance Drain	1.4	1.8	2.2	2.65	10515	1.0%	2.3	3.8	0.9
F	Van Alstine Drain	1.4	1.8	2.2	2.65	8637	1.0%	2.0	3.3	0.0
G	Tobico Marsh State Game A	0.3	0.5	0.7	0.95	12077	1.0%	4.5	7.5	0.0
H	Tobico Marsh	3.4	3.9	4.4	4.9	12360	1.0%	1.3	2.2	0.0

TOBICO MARSH WATERSHED
HYDROLOGIC CALCULATIONS SUMMARY
SAGINAW BAY, MICHIGAN

	Subwatershed	*10-year, 24-hour Design Storm Parameters* *Time to Peak Discharge* (hours)	*Peak Discharge* (cfs)	*Time to Base* (hours)	*Total Volume of Water* (cubic feet)
A	Hadd Drain	13.58	98.64	36.2586	1.74E+06
B	Dubay Drain	14.08	126.62	37.5936	2.88E+06
C	Wetters Drain	13.58	106.78	36.2586	1.88E+06
D	Tobico Drain	13.68	109.55	36.5256	2.04E+06
E	Lesperance Drain	14.18	145.61	37.8606	3.48E+06
F	Van Alstine Drain	13.88	120.50	37.0596	2.51E+06
G	Tobico Marsh State Game A	16.38	93.90	43.7346	9.41E+05
H	Tobico Marsh	13.18	337.06	35.1906	1.11E+07
					2.66E+07

TOBICO MARSH WATERSHED
PEAK FLOW THROUGH FLAP GATE
SAGINAW BAY, MICHIGAN

	Subwatershed	*Catchment Area (acres)*	*Lag to Marsh Outlet (hours)*	*Contribution from each reach to Marsh Outlet (cfs)* *Time (hours)*	0	5	10	11	12	13	14	15	16	17	18	19	20	25	30	35	40	45
B	Dubay Drain	566.5	1.9		0	28	72	80	90	99	108	117	126	121	115	110	105	78	51	24	0	0
C	Wetters Drain	370.7	1.5		0	26	66	74	83	90	98	107	102	97	92	88	83	60	37	14	0	0
D	Tobico Drain	401.2	1.1		0	32	72	80	88	96	103	109	102	98	93	89	84	60	35	12	0	0
E	Lesperance Drain	685.6	0.9		0	40	92	102	112	122	133	143	140	133	128	122	116	85	54	23	0	0
G	Tobico Marsh State Game Area	863.7	0.0		0	28	58	63	68	74	80	86	92	93	88	84	81	64	47	30	12	0
H	Tobico Marsh	897.7	0.0		0	125	255	280	305	335	325	310	290	280	265	250	235	155	80	5	0	0
		3785.4			0	279	615	679	746	816	847	$\boxed{872}$	852	822	781	743	704	502	304	108	12	0


Hydrograph for Tobico Marsh Outlet - Through Flap Gate
Discharge (cfs)
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
Time (Hours)

TOBICO MARSH WATERSHED
PEAK FLOW THROUGH TOBICO LAGOON
SAGINAW BAY, MICHIGAN

	Subwatershed	Catchment Area (acres)	Lag to Marsh Outlet (hours)	Contribution from each reach to Marsh Outlet (cfs) Time (hours)	0	5	10	11	12	13	14	15	16	17	18	19	20	25	30	35	40	45
B	Dubay Drain	566.5	1.9		0	28	72	80	90	99	108	117	126	121	115	110	105	78	51	24	0	0
C	Wetters Drain	370.7	1.5		0	26	66	74	83	90	98	107	102	97	92	88	83	60	37	14	0	0
D	Tobico Drain	401.2	1.1		0	32	72	80	88	96	103	109	102	98	93	89	84	60	35	12	0	0
E	Lesperance Drain	685.6	0.9		0	40	92	102	112	122	133	143	140	133	128	122	116	85	54	23	0	0
F	Van Alstine Drain	494.0	0.0		0	44	86	95	104	113	120	115	109	104	99	94	89	63	36	10	0	0
G	Tobico Marsh State Game Area	863.7	0.0		0	28	58	63	68	74	80	86	92	93	88	84	81	64	47	30	12	0
H	Tobico Marsh	897.7	0.0		0	125	255	280	305	335	325	310	290	280	265	250	235	155	80	5	0	0
		4279.4			0	323	701	774	850	929	967	$\boxed{987}$	961	926	880	837	793	565	340	118	12	0

Entire Marsh Together as one Catchment Area

Area	4279	acres
Hydraulic Length	25000	feet
Lag	1.9	hours
Time of Concentration	3.16666667	

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED A
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

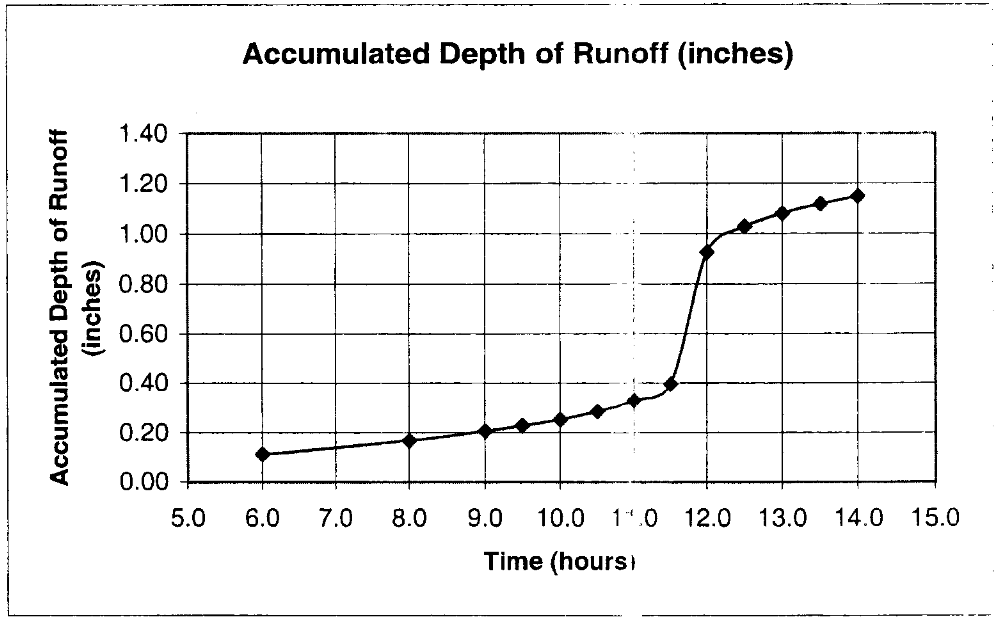
Sub-Watershed A

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
0.54	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	6938	1%	1.7	0.68	4.76

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
13.7	26.50	34.07	41.64	50.16

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
8.82

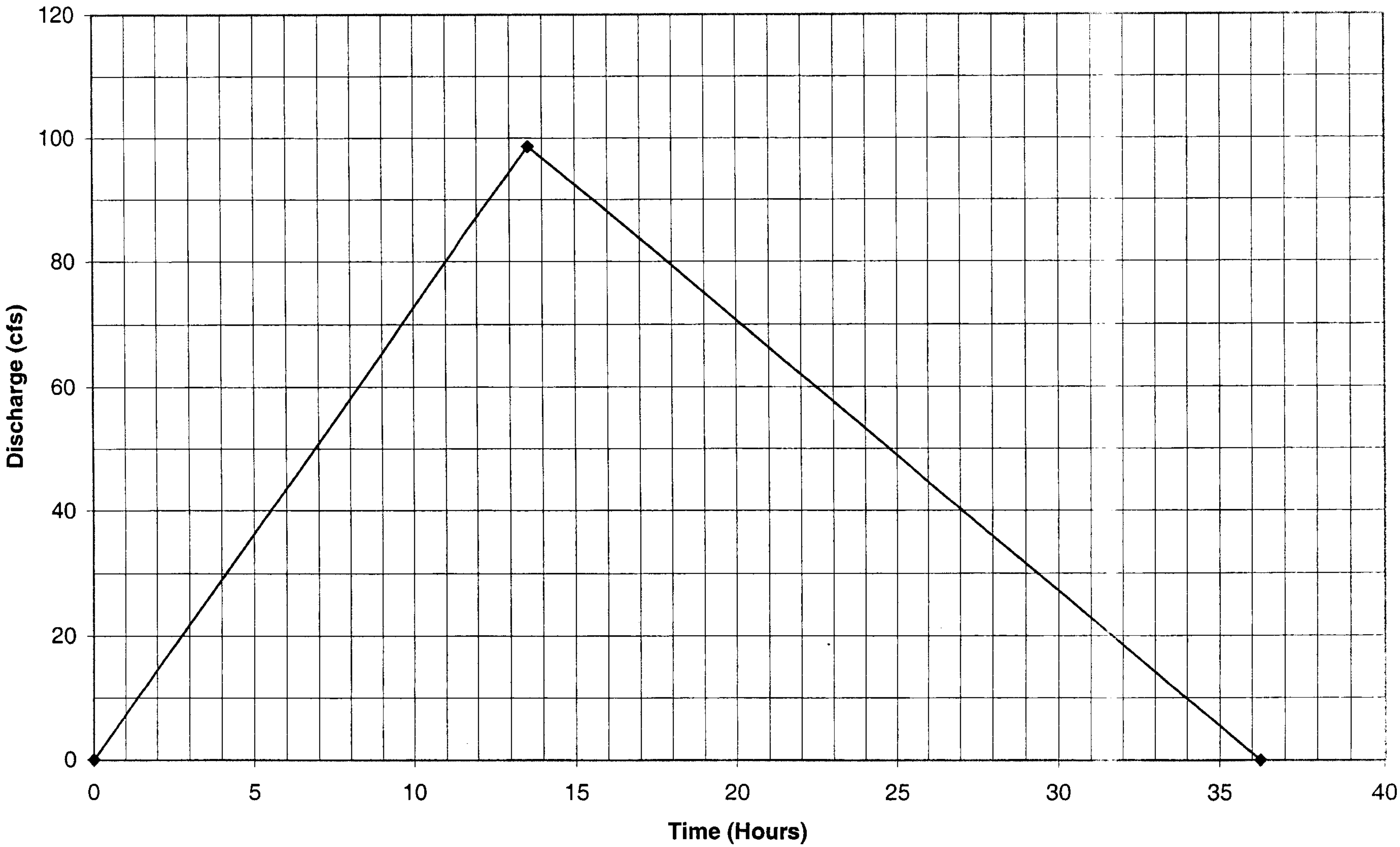
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED A
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	8.82	0.20	0.03	3.8135018	0.20	0.76	
ΔD_2	9.50	0.23	0.03	3.8135018	0.40	1.53	
ΔD_3	10.18	0.26	0.06	7.6270037	0.60	4.58	
ΔD_4	10.86	0.32	0.09	11.440506	0.80	9.15	
ΔD_5	11.54	0.41	0.57	72.456535	1.00	72.46	
ΔD_6	12.22	0.98	0.09	11.440506	0.67	7.63	
ΔD_7	12.90	1.07	0.06	7.6270037	0.33	2.54	
	13.58	1.13				98.64	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	13.58	98.64
Time to Base	36.2586	0

Triangular Hydrograph - Subwatershed A



PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED B
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

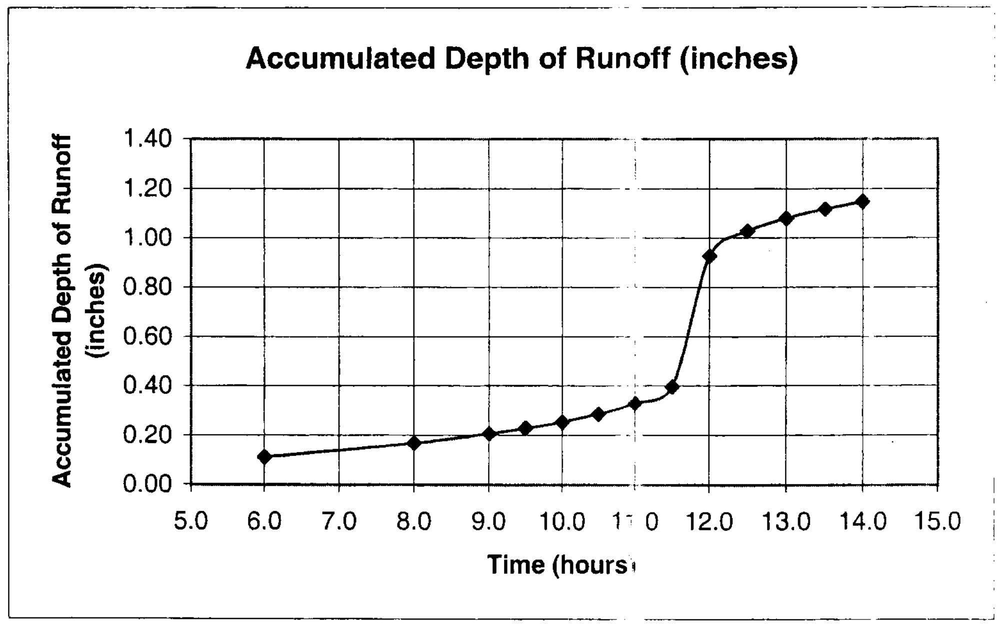
Sub-Watershed B

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
0.89	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	9377	1%	2.2	0.88	6.16

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
14.2	42.47	54.60	66.74	80.39

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
7.92

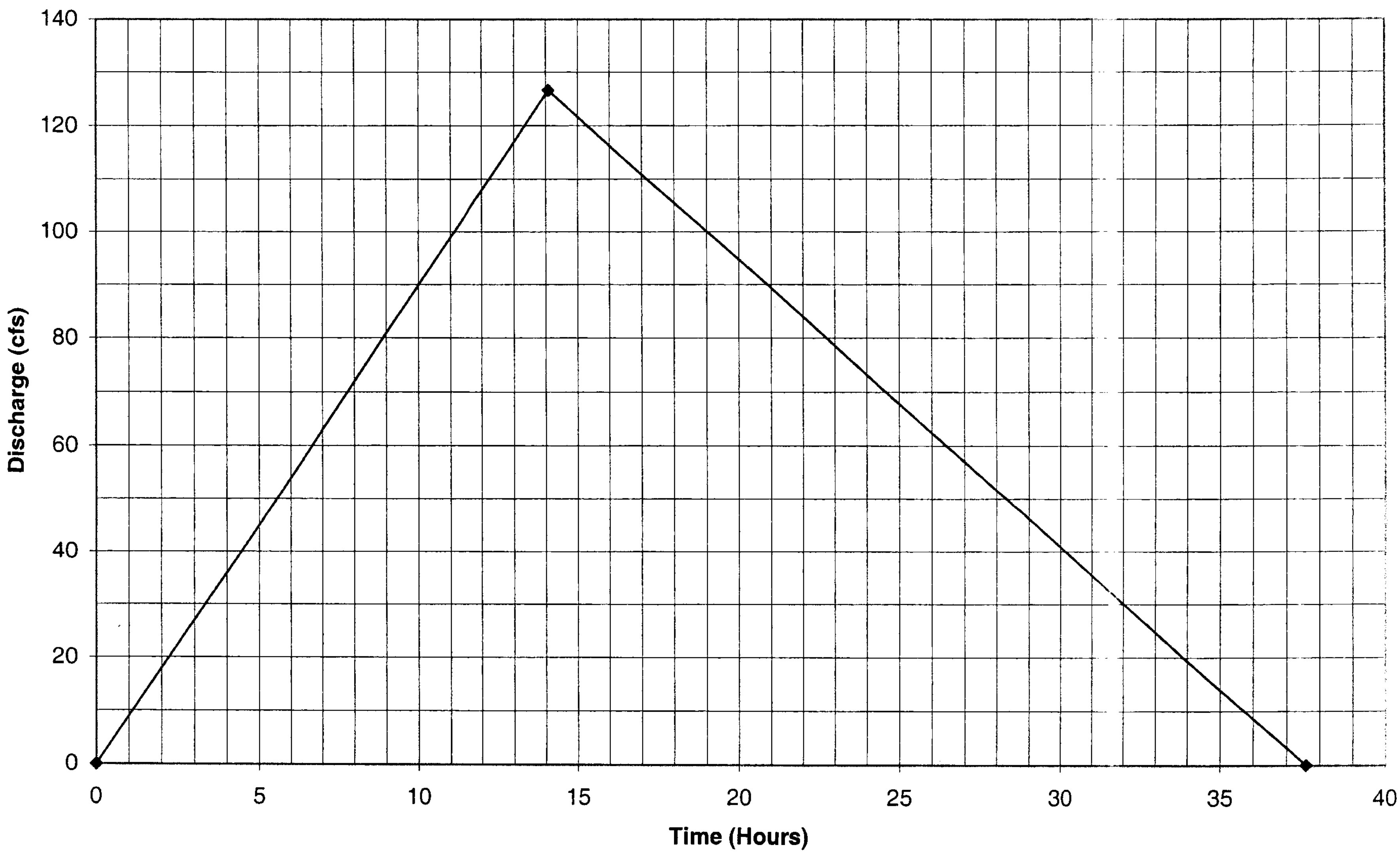
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED B
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	7.92	0.20	0.03	4.895	0.20	0.98	
ΔD_2	8.80	0.23	0.03	4.895	0.40	1.96	
ΔD_3	9.68	0.26	0.06	9.79	0.60	5.87	
ΔD_4	10.56	0.32	0.09	14.685	0.80	11.75	
ΔD_5	11.44	0.41	0.57	93.005	1.00	93.01	
ΔD_6	12.32	0.98	0.09	14.685	0.67	9.79	
ΔD_7	13.20	1.07	0.06	9.79	0.33	3.26	
	14.08	1.13				126.62	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	14.08	126.62
Time to Base	37.5936	0

Triangular Hydrograph - Subwatershed B



PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED C
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

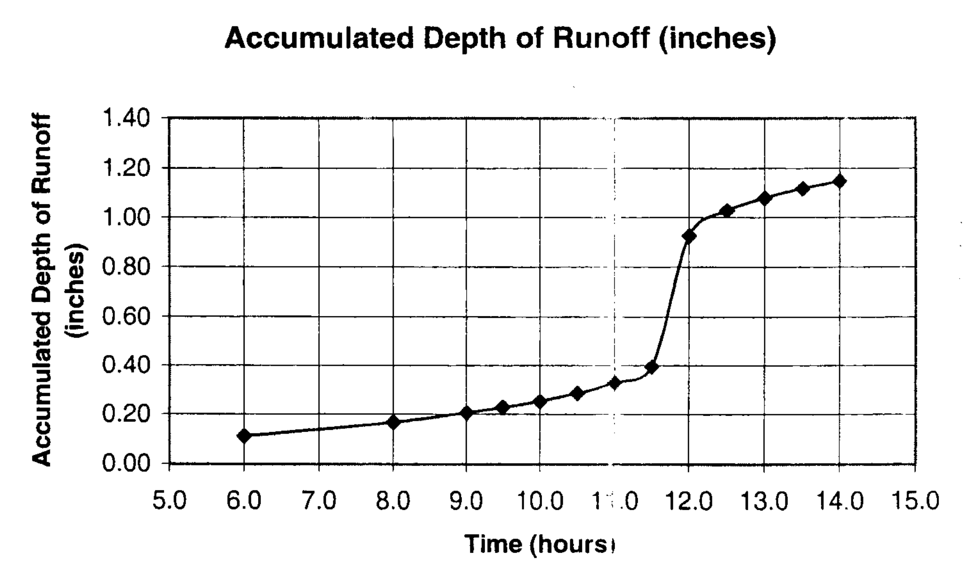
Sub-Watershed C

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
0.58	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	7270	1%	1.7	0.68	4.76

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
13.7	28.69	36.88	45.08	54.30

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

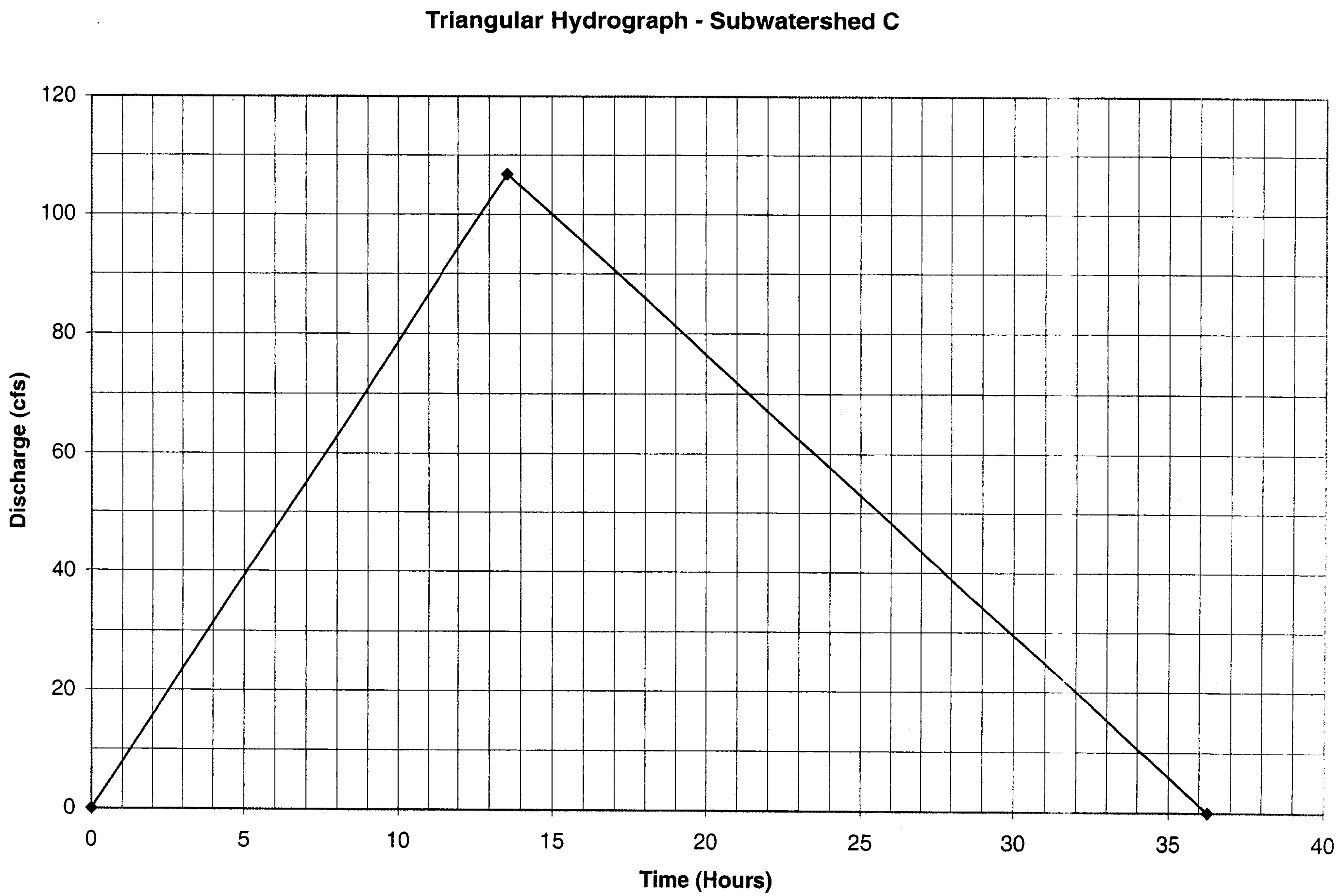
Starting Point of Effective Peak Producing Period
8.82

Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED C
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	8.82	0.20	0.03	4.1282353	0.20	0.83	
ΔD_2	9.50	0.23	0.03	4.1282353	0.40	1.65	
ΔD_3	10.18	0.26	0.06	8.2564706	0.60	4.95	
ΔD_4	10.86	0.32	0.09	12.384706	0.80	9.91	
ΔD_5	11.54	0.41	0.57	78.436471	1.00	78.44	
ΔD_6	12.22	0.98	0.09	12.384706	0.67	8.26	
ΔD_7	12.90	1.07	0.06	8.2564706	0.33	2.75	
	13.58	1.13				106.78	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	13.58	106.78
Time to Base	36.2586	0


Triangular Hydrograph - Subwatershed C
Discharge (cfs)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
Time (Hours)

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED D
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

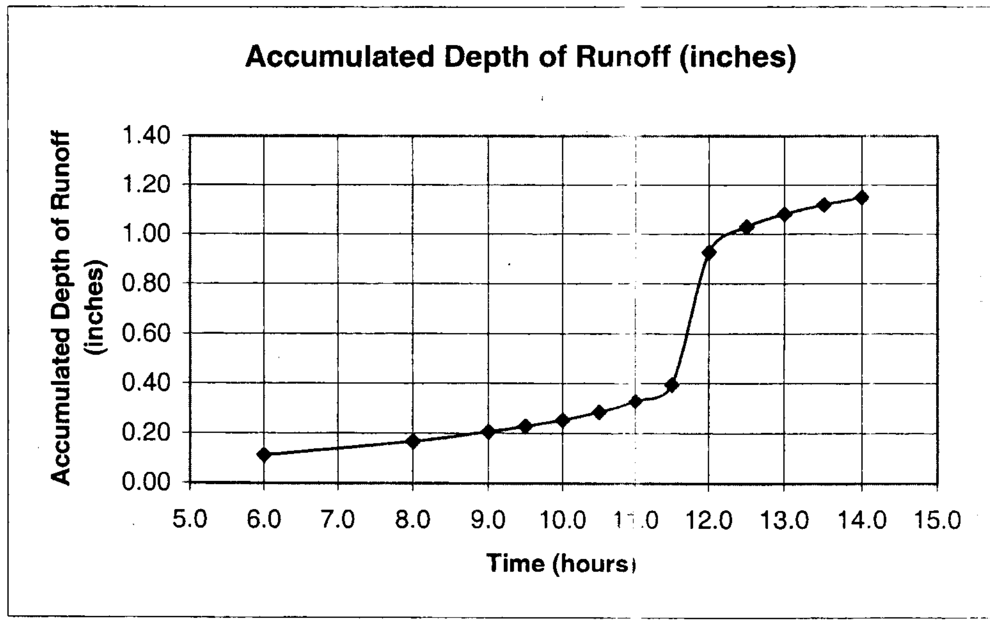
Sub-Watershed D

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
0.63	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	7624	1%	1.8	0.72	5.04

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
13.8	30.93	39.77	48.61	58.55

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
8.64

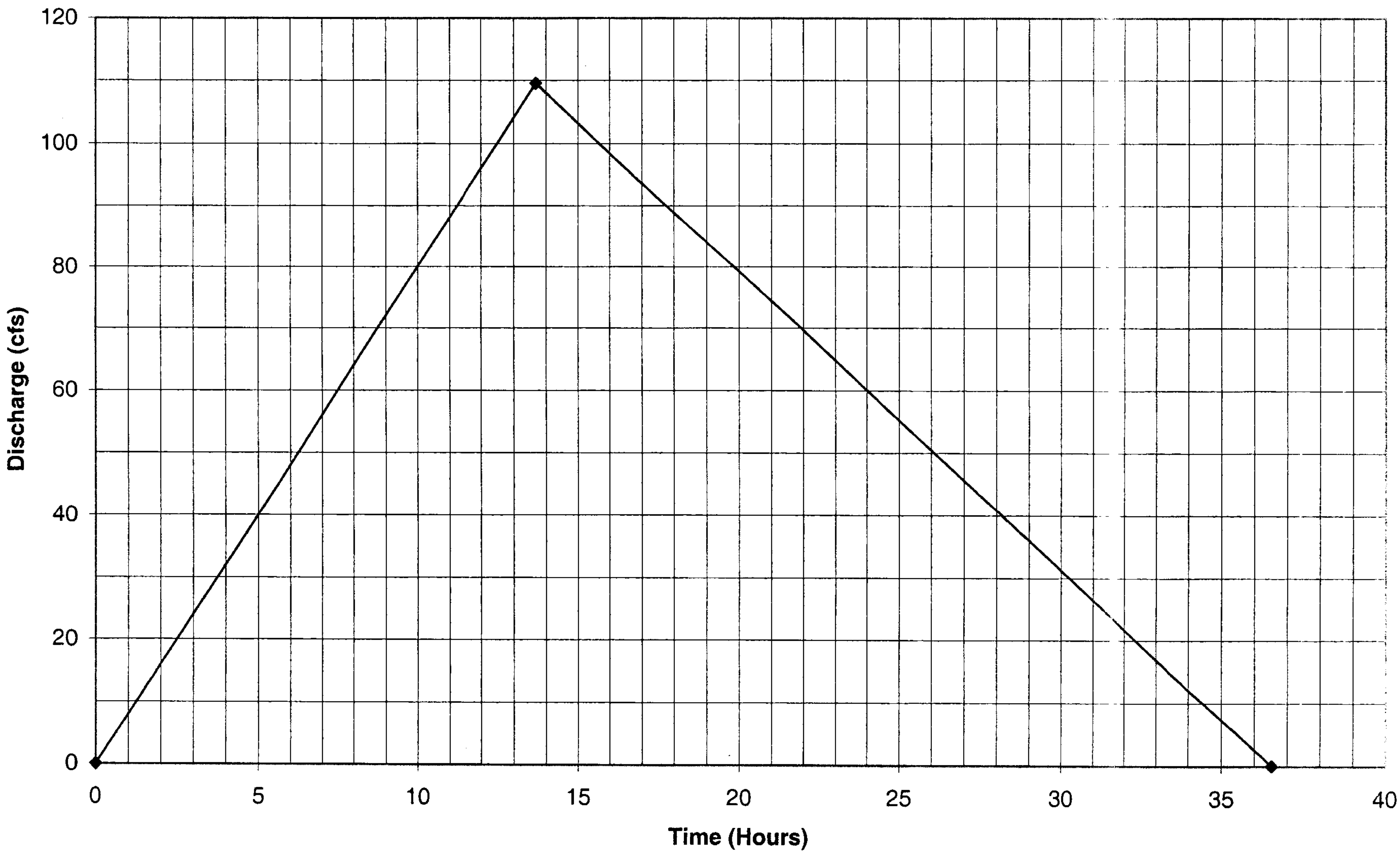
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED D
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	8.64	0.20	0.03	4.235	0.20	0.85	
ΔD_2	9.36	0.23	0.03	4.235	0.40	1.69	
ΔD_3	10.08	0.26	0.06	8.47	0.60	5.08	
ΔD_4	10.80	0.32	0.09	12.705	0.80	10.16	
ΔD_5	11.52	0.41	0.57	80.465	1.00	80.47	
ΔD_6	12.24	0.98	0.09	12.705	0.67	8.47	
ΔD_7	12.96	1.07	0.06	8.47	0.33	2.82	
	13.68	1.13				109.55	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	13.68	109.55
Time to Base	36.5256	0

Triangular Hydrograph - Subwatershed D



PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED E
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

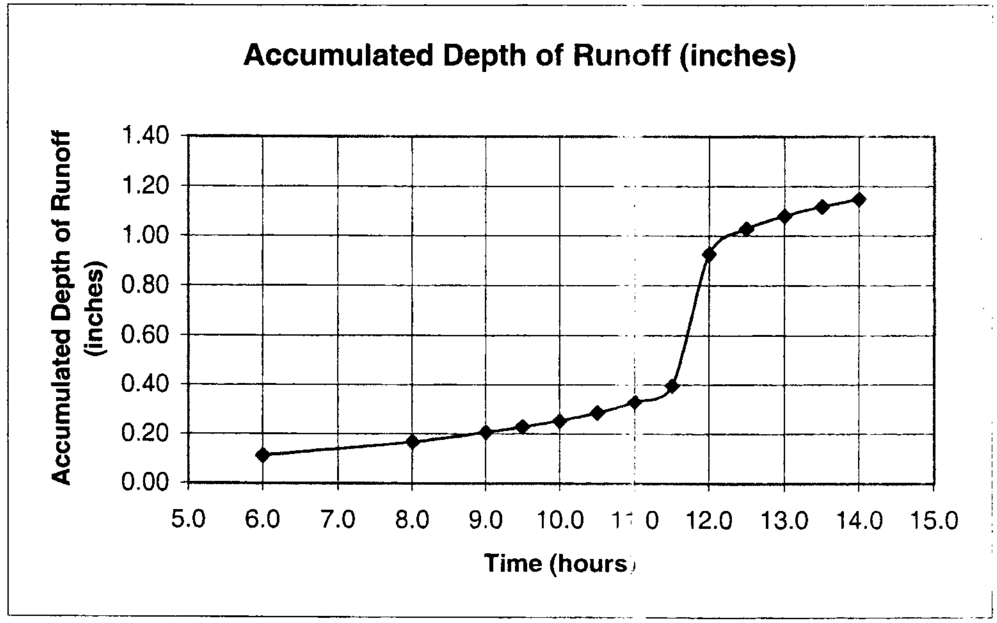
Sub-Watershed E

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
1.07	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	10515	1%	2.3	0.92	6.44

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
14.3	50.70	65.19	79.67	95.97

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
7.74

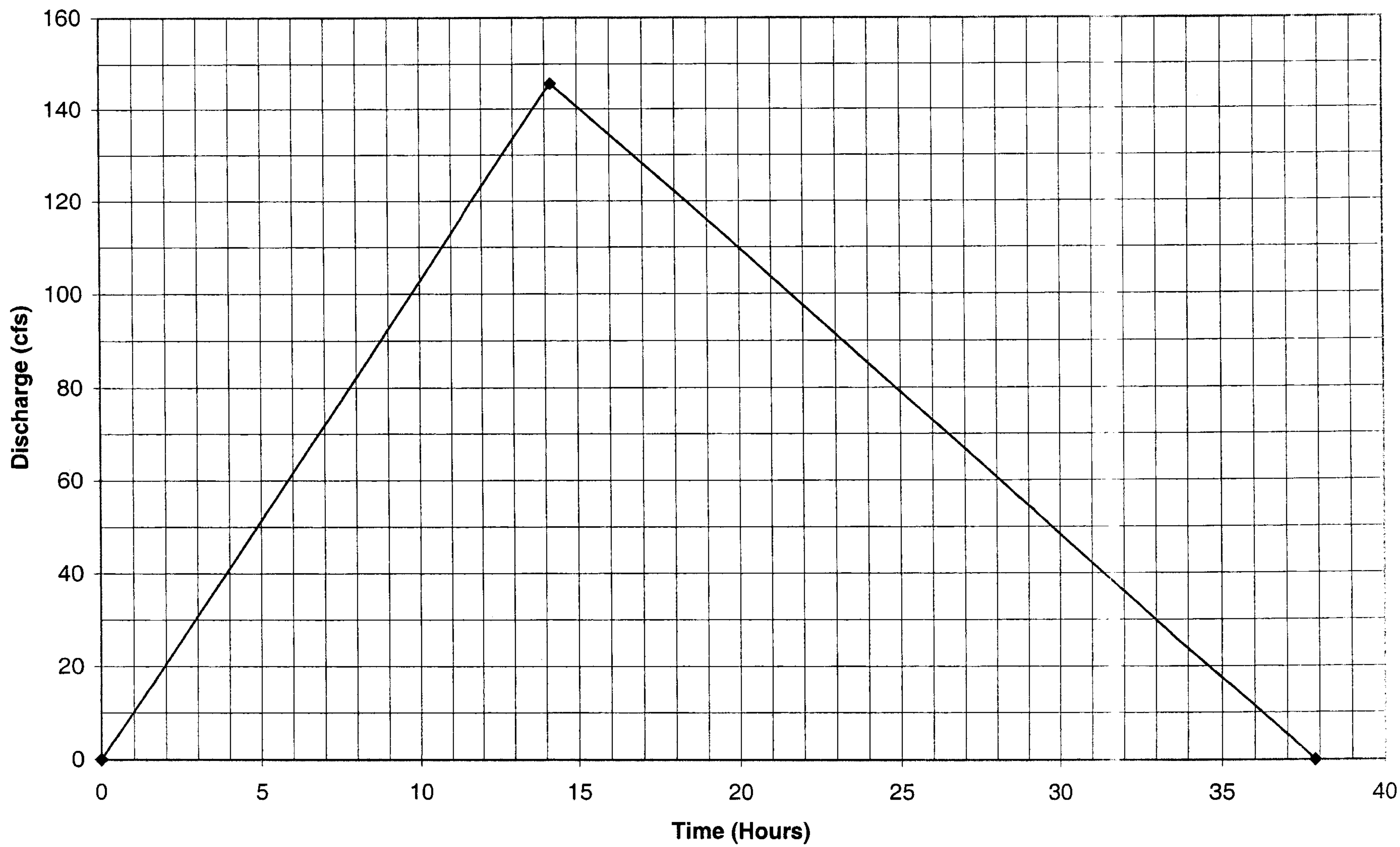
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED E
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	7.74	0.20	0.03	5.6291304	0.20	1.13	
ΔD_2	8.66	0.23	0.03	5.6291304	0.40	2.25	
ΔD_3	9.58	0.26	0.06	11.258261	0.60	6.75	
ΔD_4	10.50	0.32	0.09	16.887391	0.80	13.51	
ΔD_5	11.42	0.41	0.57	106.95348	1.00	106.95	
ΔD_6	12.34	0.98	0.09	16.887391	0.67	11.26	
ΔD_7	13.26	1.07	0.06	11.258261	0.33	3.75	
	14.18	1.13				145.61	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	14.18	145.61
Time to Base	37.8606	0

Triangular Hydrograph - Subwatershed E



PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED F
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

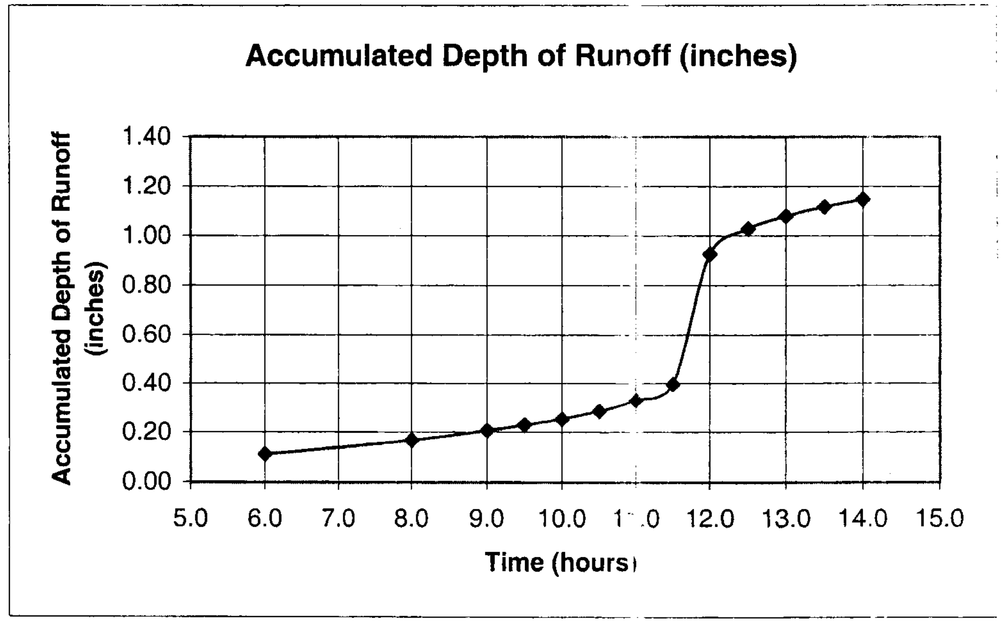
Sub-Watershed F

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
0.77	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	1.4	1.8	2.2	2.65	8637	1%	2.0	0.8	5.6

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
14	37.27	47.92	58.56	70.54

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.11
8.0	0.120	0.40	0.17
9.0	0.147	0.50	0.21
9.5	0.163	0.55	0.23
10.0	0.181	0.61	0.25
10.5	0.204	0.69	0.29
11.0	0.235	0.79	0.33
11.5	0.283	0.95	0.40
12.0	0.663	2.23	0.93
12.5	0.735	2.48	1.03
13.0	0.772	2.60	1.08
13.5	0.799	2.69	1.12
14.0	0.820	2.76	1.15



From Graph - Midpoint of Maximum Increment of Runoff
11.88

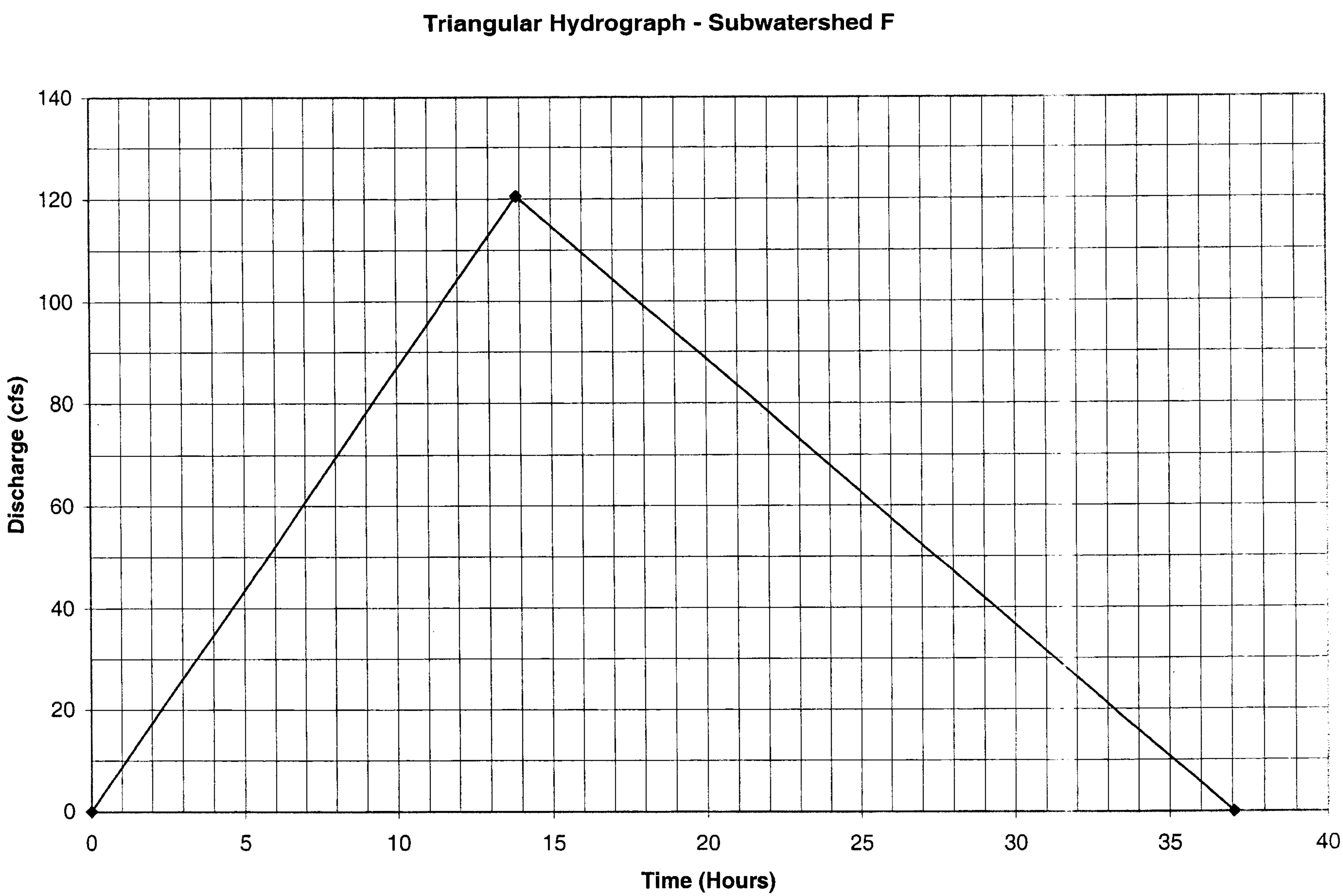
Starting Point of Effective Peak Producing Period
8.28

Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED F
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	8.28	0.20	0.03	4.6585	0.20	0.93	
ΔD_2	9.08	0.23	0.03	4.6585	0.40	1.86	
ΔD_3	9.88	0.26	0.06	9.317	0.60	5.59	
ΔD_4	10.68	0.32	0.09	13.9755	0.80	11.18	
ΔD_5	11.48	0.41	0.57	88.5115	1.00	88.51	
ΔD_6	12.28	0.98	0.09	13.9755	0.67	9.32	
ΔD_7	13.08	1.07	0.06	9.317	0.33	3.11	
	13.88	1.13				120.50	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	13.88	120.50
Time to Base	37.0596	0


Triangular Hydrograph - Subwatershed F
Discharge (cfs)
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
35
40
Time (Hours)

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED G
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

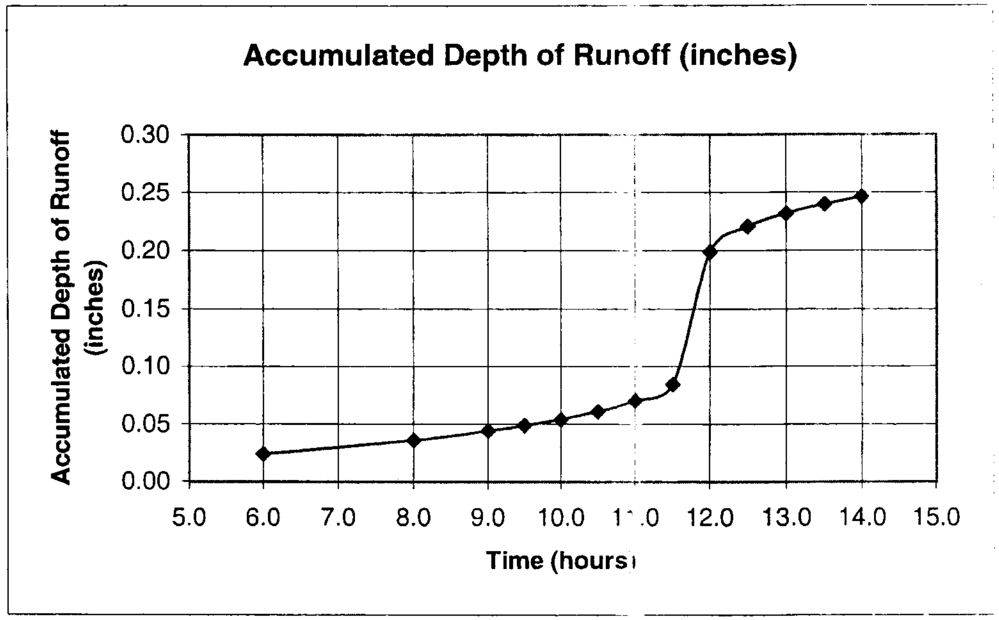
Sub-Watershed G

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*$7\Delta D$ (hours)*
1.35	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	0.3	0.5	0.7	0.95	12077	1%	4.5	1.8	12 6

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
16.5	11.88	19.80	27.72	37.62

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.02
8.0	0.120	0.40	0.04
9.0	0.147	0.50	0.04
9.5	0.163	0.55	0.05
10.0	0.181	0.61	0.05
10.5	0.204	0.69	0.06
11.0	0.235	0.79	0.07
11.5	0.283	0.95	0.08
12.0	0.663	2.23	0.20
12.5	0.735	2.48	0.22
13.0	0.772	2.60	0.23
13.5	0.799	2.69	0.24
14.0	0.820	2.76	0.25



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
3.78

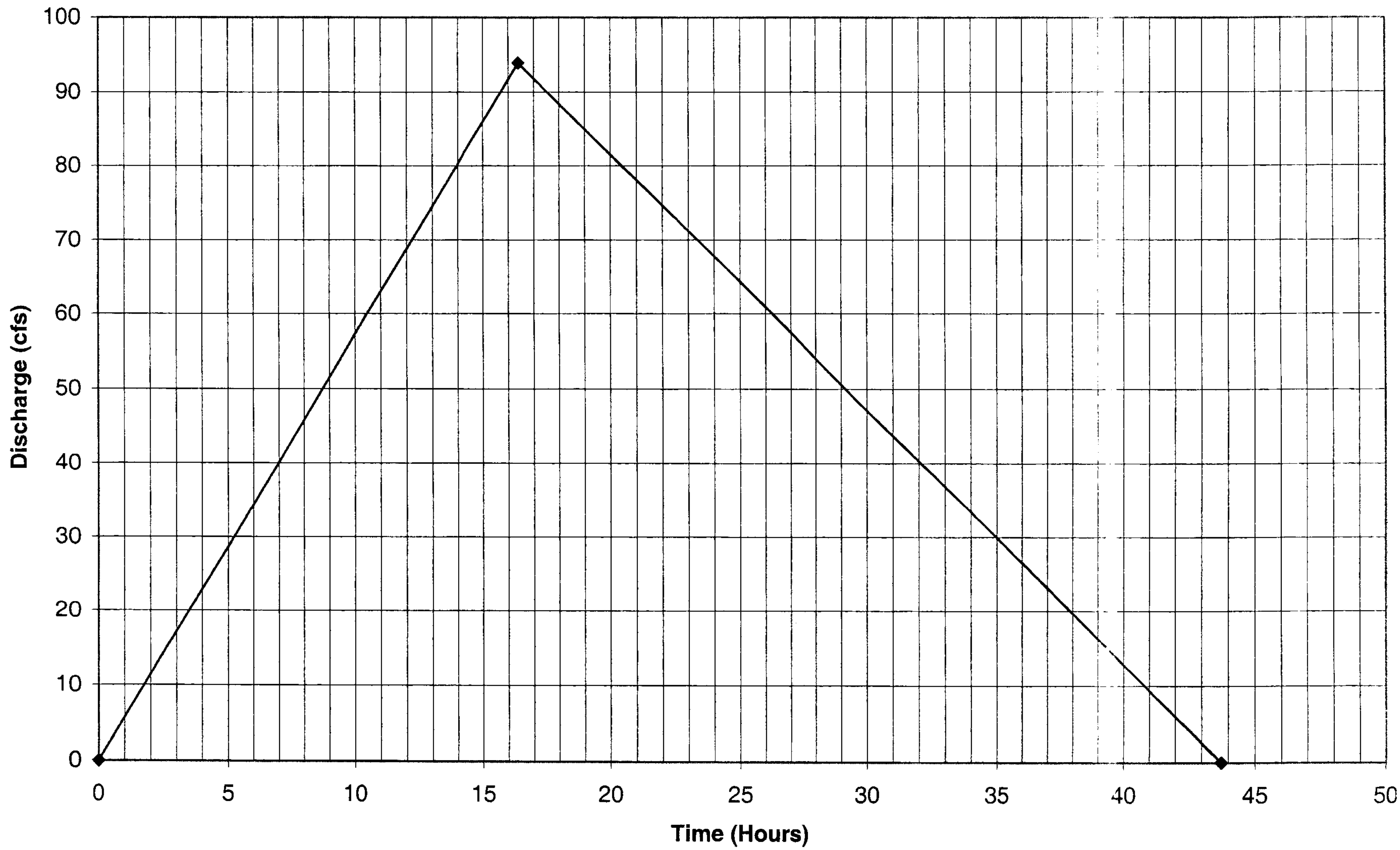
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED G
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	3.78	0.20	0.03	3.63	0.20	0.73	
ΔD_2	5.58	0.23	0.03	3.63	0.40	1.45	
ΔD_3	7.38	0.26	0.06	7.26	0.60	4.36	
ΔD_4	9.18	0.32	0.09	10.89	0.80	8.71	
ΔD_5	10.98	0.41	0.57	68.97	1.00	68.97	
ΔD_6	12.78	0.98	0.09	10.89	0.67	7.26	
ΔD_7	14.58	1.07	0.06	7.26	0.33	2.42	
	16.38	1.13				93.90	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	16.38	93.90
Time to Base	43.7346	0

Triangular Hydrograph - Subwatershed G



PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED H
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

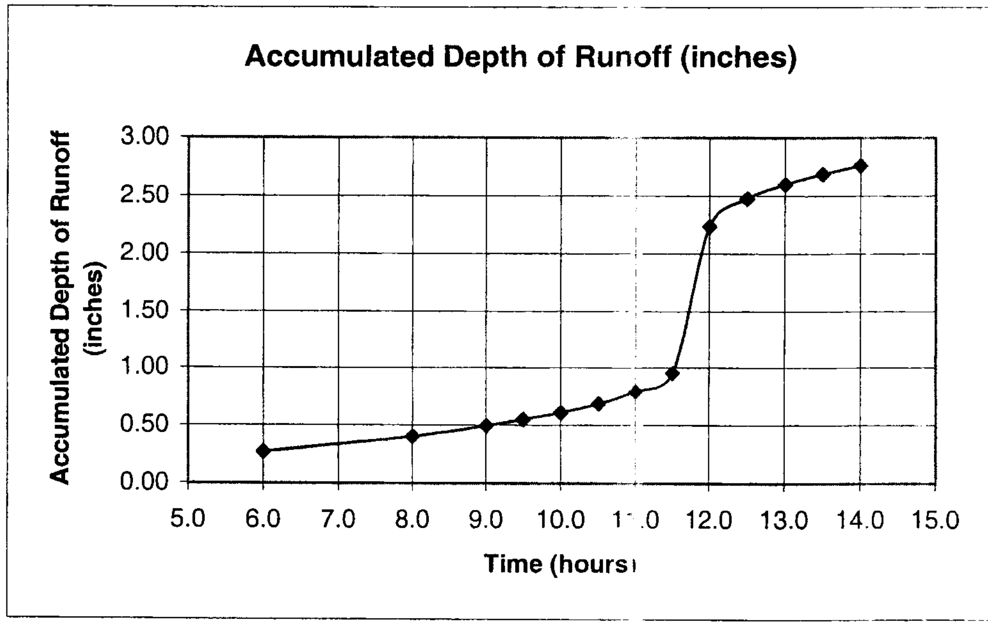
Sub-Watershed H

Catchment Area (square miles)	*D = 24-hour Rainfall in Bay County, Michigan (inches)*				*Watershed Parameters - Type II*			*Effective Peak Producing Period*	
	10-year	*25-year*	*50-year*	*100-year*	*Hydraulic Length (feet)*	*Average Slope (% slope)*	*Lag (hours)*	*ΔD (hours)*	*7ΔD (hours)*
1.40	*3.37*	*3.87*	*4.37*	*4.9*					
	Direct Runoff (inches)								
	3.37	3.87	4.37	4.9	12360	1%	1.3	0.52	3.64

Peak Discharge - Tp (hrs)	*Peak Discharge (cfs) if uniform storm assumed*			
13.3	171.69	197.17	222.64	249.64

10-year

Time (hours)	P_x/P_{24}	Mass P (inches)	Mass Q (inches)
6.0	0.080	0.27	0.27
8.0	0.120	0.40	0.40
9.0	0.147	0.50	0.50
9.5	0.163	0.55	0.55
10.0	0.181	0.61	0.61
10.5	0.204	0.69	0.69
11.0	0.235	0.79	0.79
11.5	0.283	0.95	0.95
12.0	0.663	2.23	2.23
12.5	0.735	2.48	2.48
13.0	0.772	2.60	2.60
13.5	0.799	2.69	2.69
14.0	0.820	2.76	2.76



From Graph - Midpoint of Maximum Increment of Runoff
11.88

Starting Point of Effective Peak Producing Period
9.54

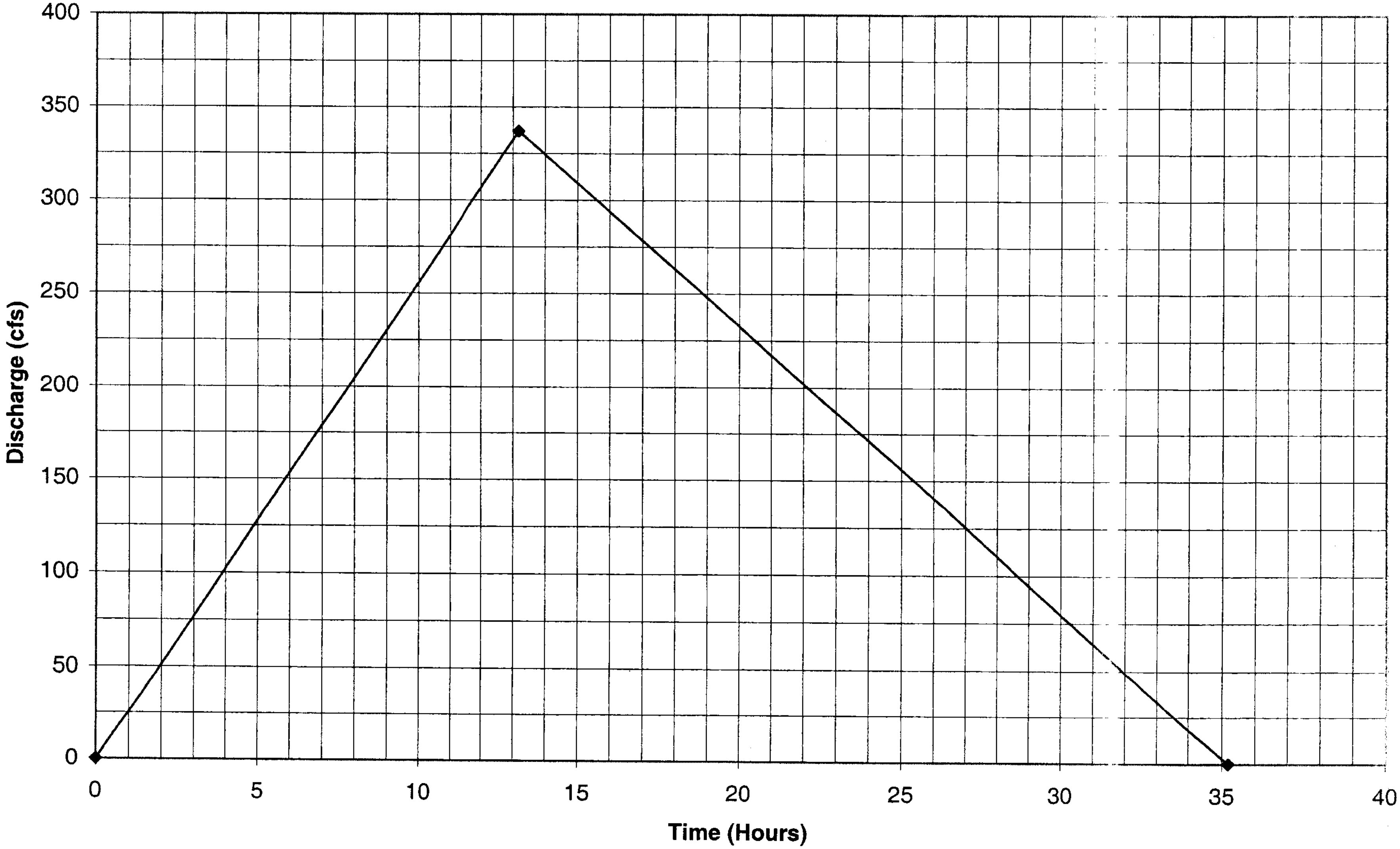
Peak Discharge if non-uniform rainfall (more realistic) - SCS Method

PEAK DISCHARGE HYDROGRAPH
SUBWATERSHED H
TOBICO MARSH WATERSHED
SAGINAW BAY, MICHIGAN

Increment	Time (hours)	Mass Runoff (inches)	ΔQ (inches)	Δq (cfs)	Proportion contributing	Discharge (cfs)	
ΔD_1	9.54	0.20	0.03	13.030769	0.20	2.61	
ΔD_2	10.06	0.23	0.03	13.030769	0.40	5.21	
ΔD_3	10.58	0.26	0.06	26.061538	0.60	15.64	
ΔD_4	11.10	0.32	0.09	39.092308	0.80	31.27	
ΔD_5	11.62	0.41	0.57	247.58462	1.00	247.58	
ΔD_6	12.14	0.98	0.09	39.092308	0.67	26.06	
ΔD_7	12.66	1.07	0.06	26.061538	0.33	8.69	
	13.18	1.13				337.06	Peak Discharge

Triangular Hydrograph	Time	Discharge
Start of Storm	0	0
Time to Peak	13.18	337.06
Time to Base	35.1906	0

Triangular Hydrograph - Subwatershed H



RUNOFF CURVE NUMBER COMPUTATION

Version 2.10
Project : Tobico Marsh User: CRA Date: 11-28-2002
County : USA State: MI Checked: ____ Date: ________

Subtitle: Marsh as 1 watershed
Subarea : Dubay

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
			Acres (CN)			
CULTIVATED AGRICULTURAL LANDS						
Row crops	Straight row (SR)	good	-	2518(78)	-	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	864(55)	-	-
Total Area (by Hydrologic Soil Group)				3382 ====		

SUBAREA: Dubay TOTAL DRAINAGE AREA: 3382 Acres WEIGHTED CURVE NUMBER: 72*

---

* - Generated for use by GRAPHIC method

GRAPHICAL PEAK DISCHARGE METHOD

Version 2.10
Project : Tobico Marsh User: CRA Date: 11-28-2002
County : USA State: MI Checked: ____ Date: ________

Subtitle: Marsh as 1 watershed

Data: Drainage Area : 4280 * Acres
Runoff Curve Number : 73 *
Time of Concentration: 3.20 Hours
Rainfall Type : II
Pond and Swamp Area : NONE

Storm Number	1	2	3	4
Frequency (yrs)	10	25	50	100
24-Hr Rainfall (in)	3.37	3.87	4.37	4.90
Ia/P Ratio	0.22	0.19	0.17	0.15
Runoff (in)	1.09	1.43	1.80	2.20
Unit Peak Discharge (cfs/acre/in)	0.223	0.229	0.234	0.237
Pond and Swamp Factor 0.0% Ponds Used	1.00	1.00	1.00	1.00
Peak Discharge (cfs)	1044	1407	1798	2238

* - Value(s) provided from TR-55 system routines

RUNOFF CURVE NUMBER COMPUTATION

Version 2.10
Project : Tobico Marsh   User: CRA   Date: 11-28-2002
County : USA   State: MI   Checked: ____   Date: ________

Subtitle: Marsh as 1 watershed
Subarea : Dubay

COVER DESCRIPTION			Hydrologic Soil Group A	B	C	D
				Acres (CN)		
CULTIVATED AGRICULTURAL LANDS						
Row crops	Straight row (SR)	good	-	3416(78)	-	-
OTHER AGRICULTURAL LANDS						
Woods		good	-	864(55)	-	-
Total Area (by Hydrologic Soil Group)				4280 ====		

SUBAREA: Dubay TOTAL DRAINAGE AREA: 4280 Acres   WEIGHTED CURVE NUMBER: 73*

---

* - Generated for use by GRAPHIC method

GRAPHICAL PEAK DISCHARGE METHOD

Version 2.10
Project : Tobico Marsh   User: CRA   Date: 11-28-2002
County : USA   State: MI   Checked: ____   Date: ________

Subtitle: Marsh as 1 watershed

Data: Drainage Area   : 4280 * Acres
      Runoff Curve Number   : 73 *
      Time of Concentration: 3.20   Hours
      Rainfall Type   : II
      Pond and Swamp Area   . .5 Sq miles   0.0 % of Drainage Area

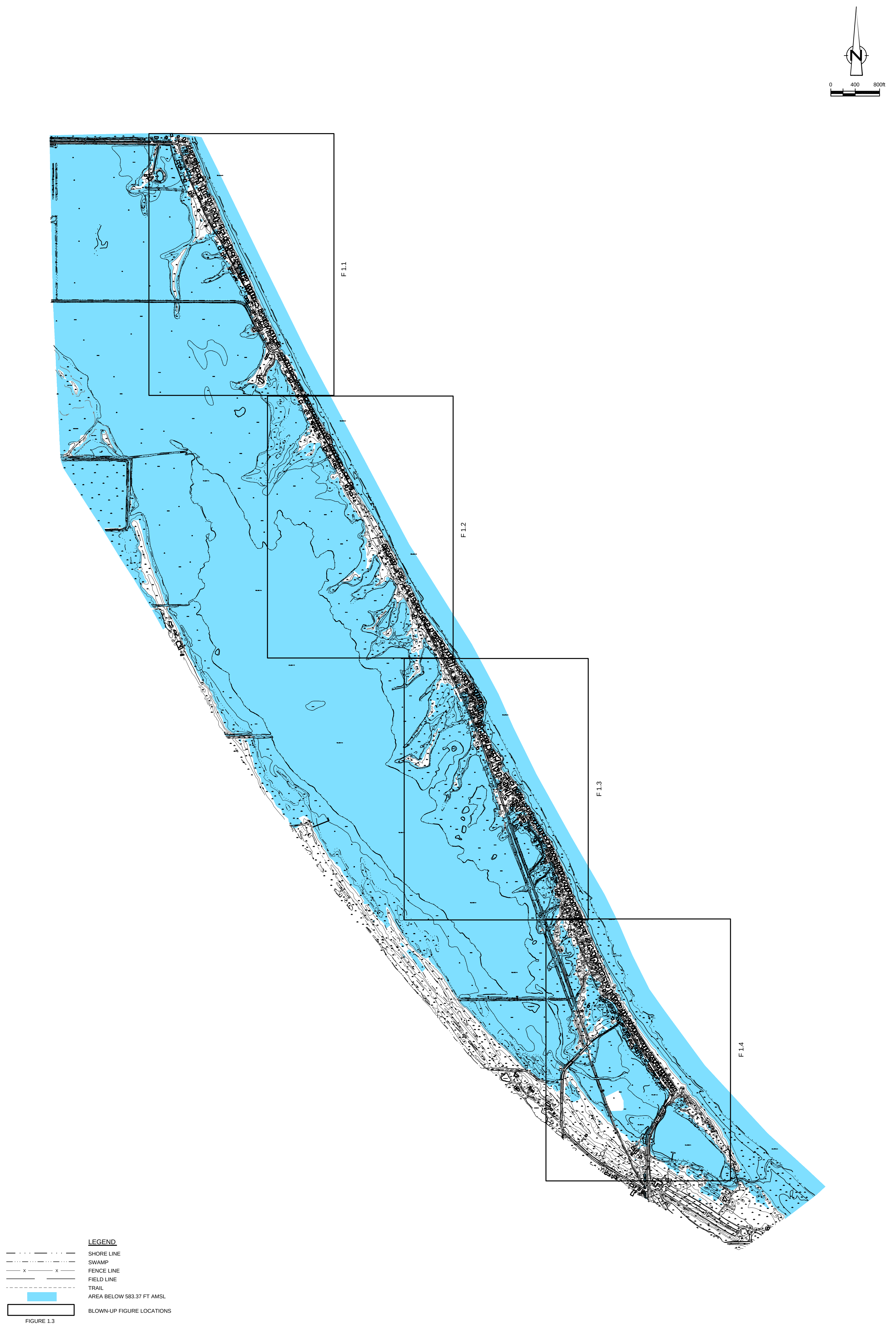
Storm Number	1	2	3	4
Frequency (yrs)	10	25	50	100
24-Hr Rainfall (in)	3.37	3.87	4.37	4.90
Ia/P Ratio	0.22	0.19	0.17	0.15
Runoff (in)	1.09	1.43	1.80	2.20
Unit Peak Discharge (cfs/acre/in)	0.223	0.229	0.234	0.237
Pond and Swamp Factor 5.0% Ponds Used	0.72	0.72	0.72	0.72
Peak Discharge (cfs)	752	1013	1295	1611

* - Value(s) provided from TR-55 system routines

APPENDIX F

FIGURES IDENTIFYING AREAS OF FLOODING

- 100-YEAR FLOOD LEVEL
- RECORDED HIGH WATER LEVEL IN SAGINAW BAY



Nº	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

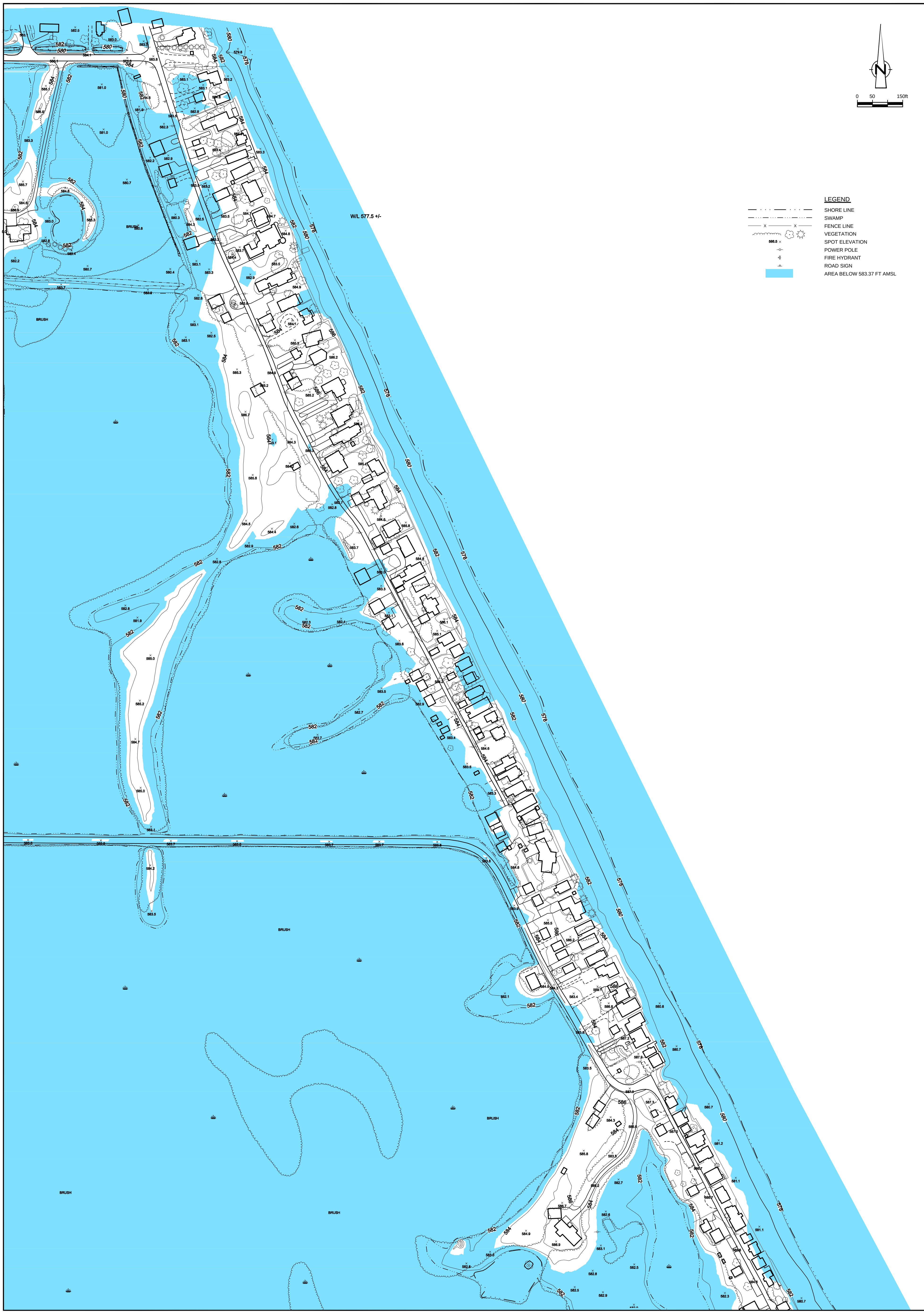
AREA OF FLOODING UNDER RECORDED HIGH WATER LEVEL IN SAGINAW BAY (583.37)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 800'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 1.0

18204-03(013)GN-WA010 OCT 01/2004



Nº	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

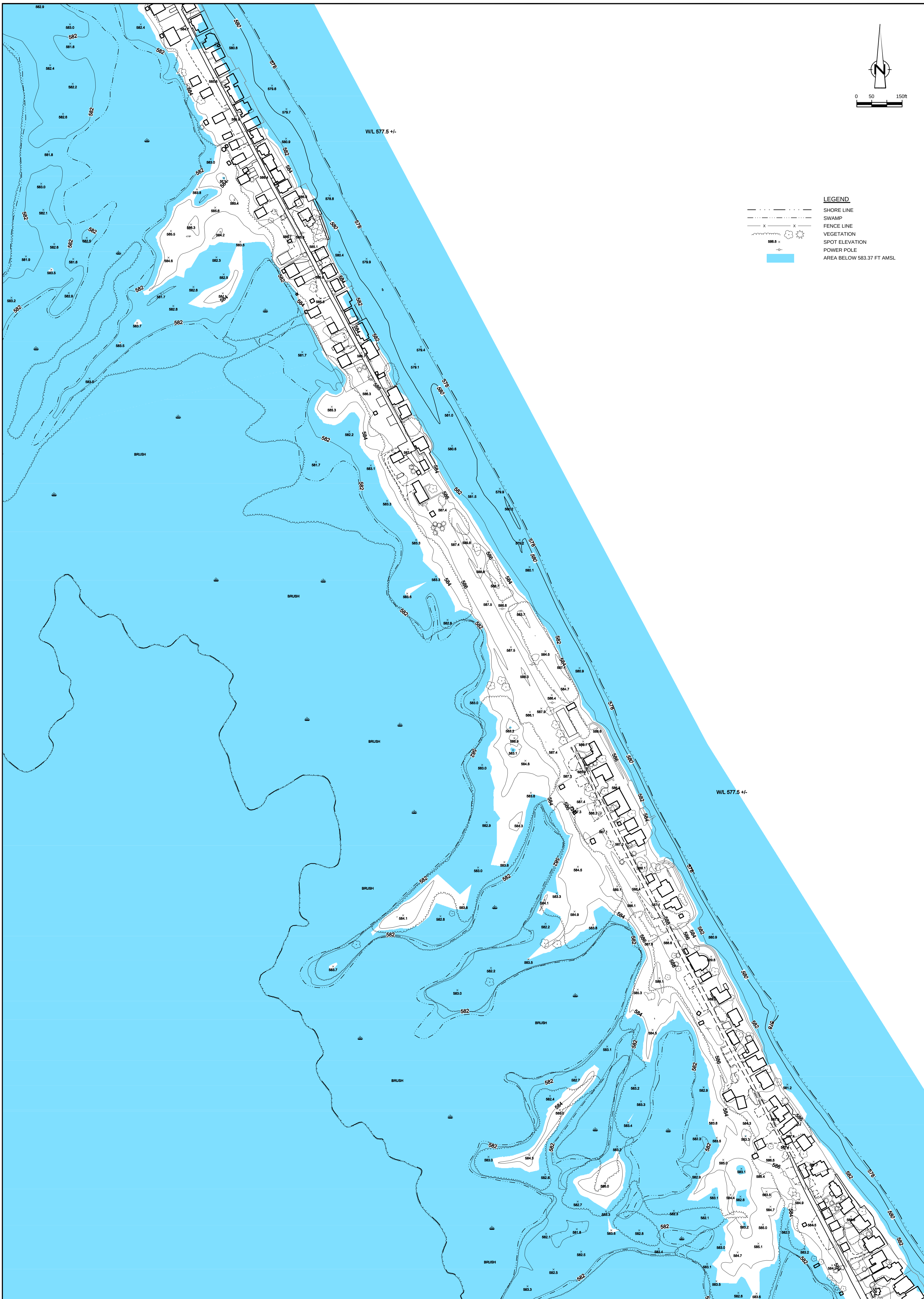
AREA OF FLOODING UNDER RECORDED HIGH WATER LEVEL IN SAGINAW BAY (583.37)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 150'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 1.1

18204-03(013)GN-WA010 OCT 01/2004



Nº	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

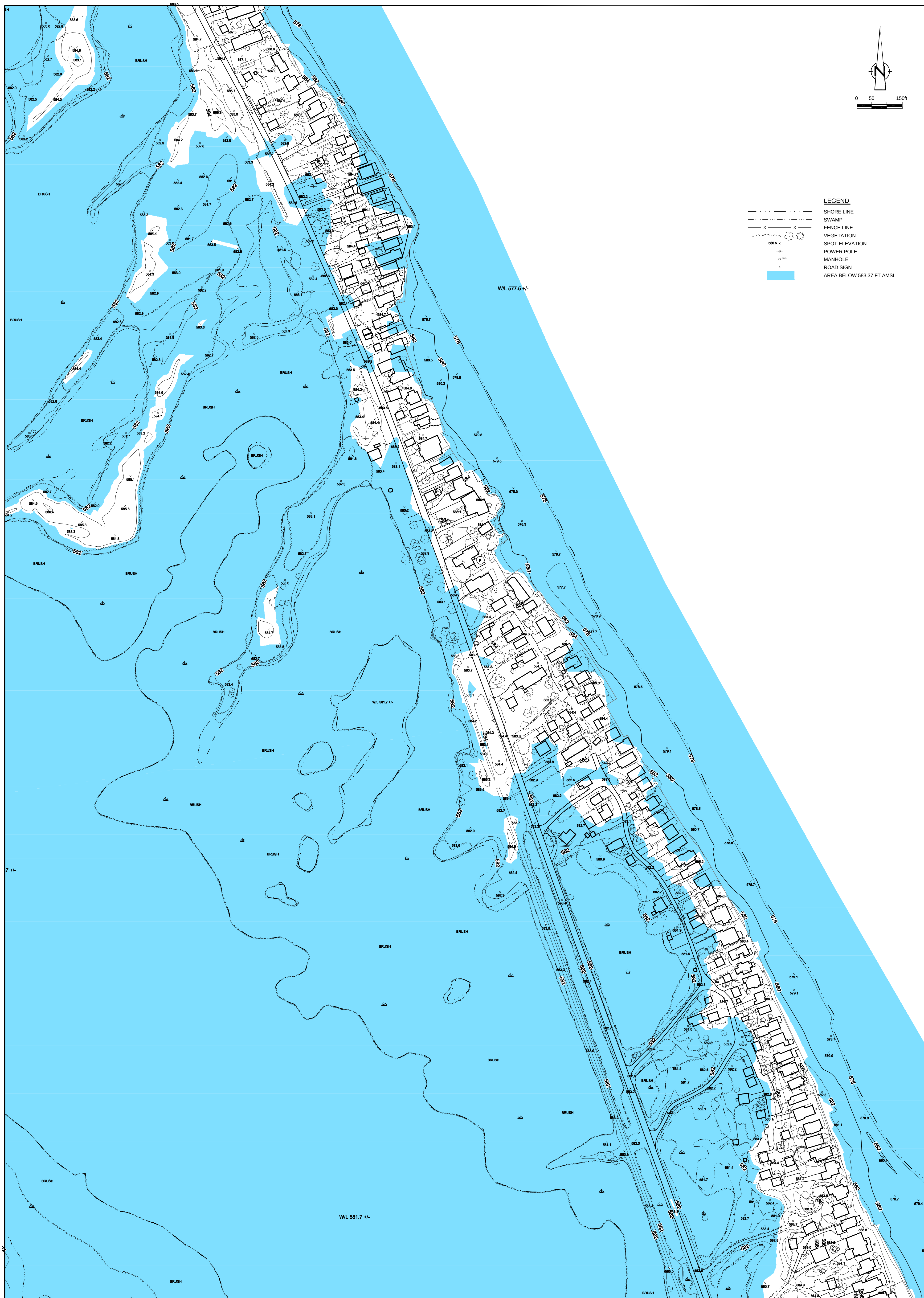
AREA OF FLOODING UNDER RECORDED HIGH WATER LEVEL IN SAGINAW BAY (583.37)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 150'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 1.2

18204-03(013)GN-WA010 OCT 01/2004



Nº	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

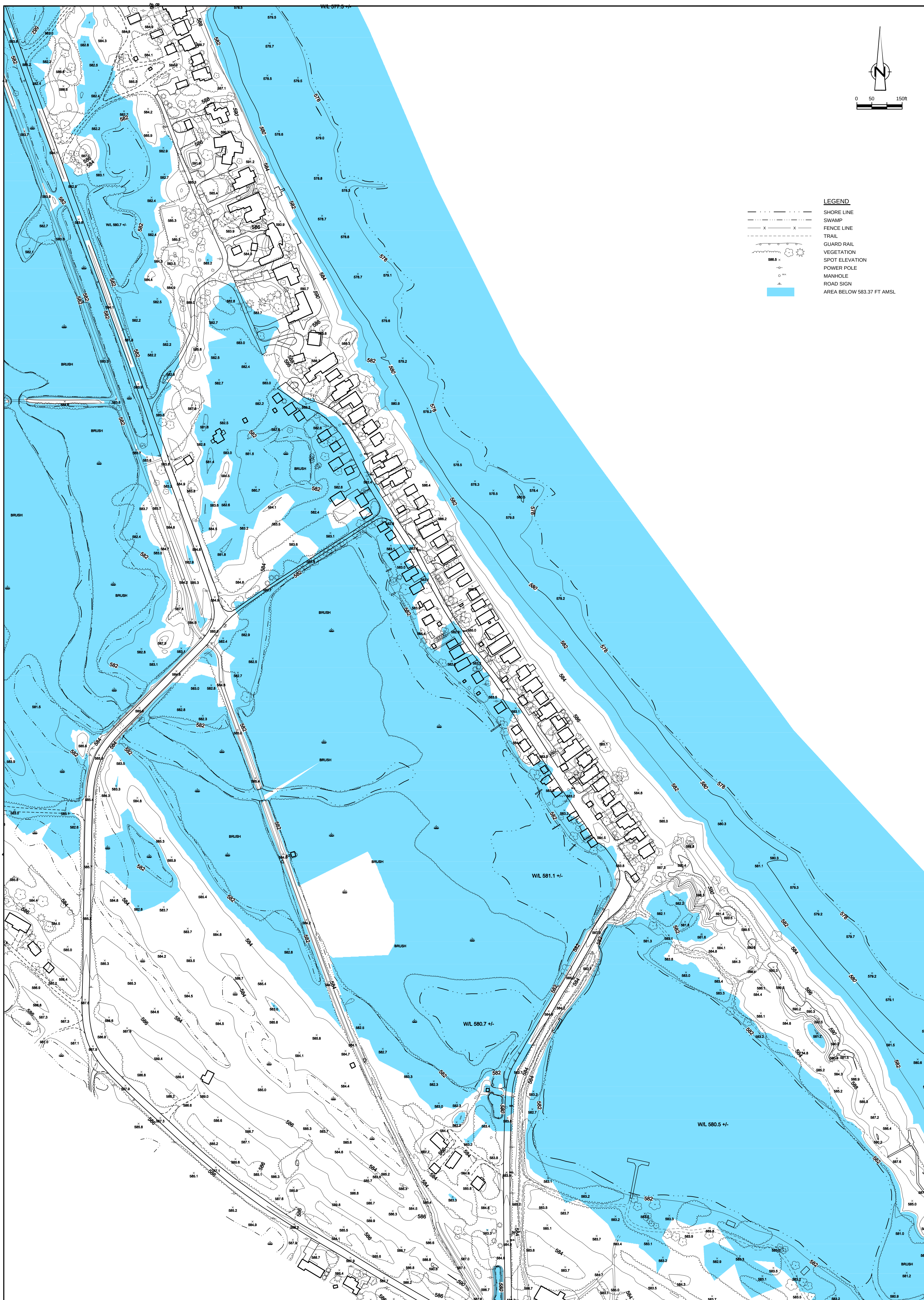
AREA OF FLOODING UNDER RECORDED HIGH WATER LEVEL IN SAGINAW BAY (583.37)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 150'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 1.3

18204-03(013)GN-WA010 OCT 01/2004



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Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

AREA OF FLOODING UNDER RECORDED HIGH WATER LEVEL IN SAGINAW BAY (583.37)

CONESTOGA-ROVERS & ASSOCIATES

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ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

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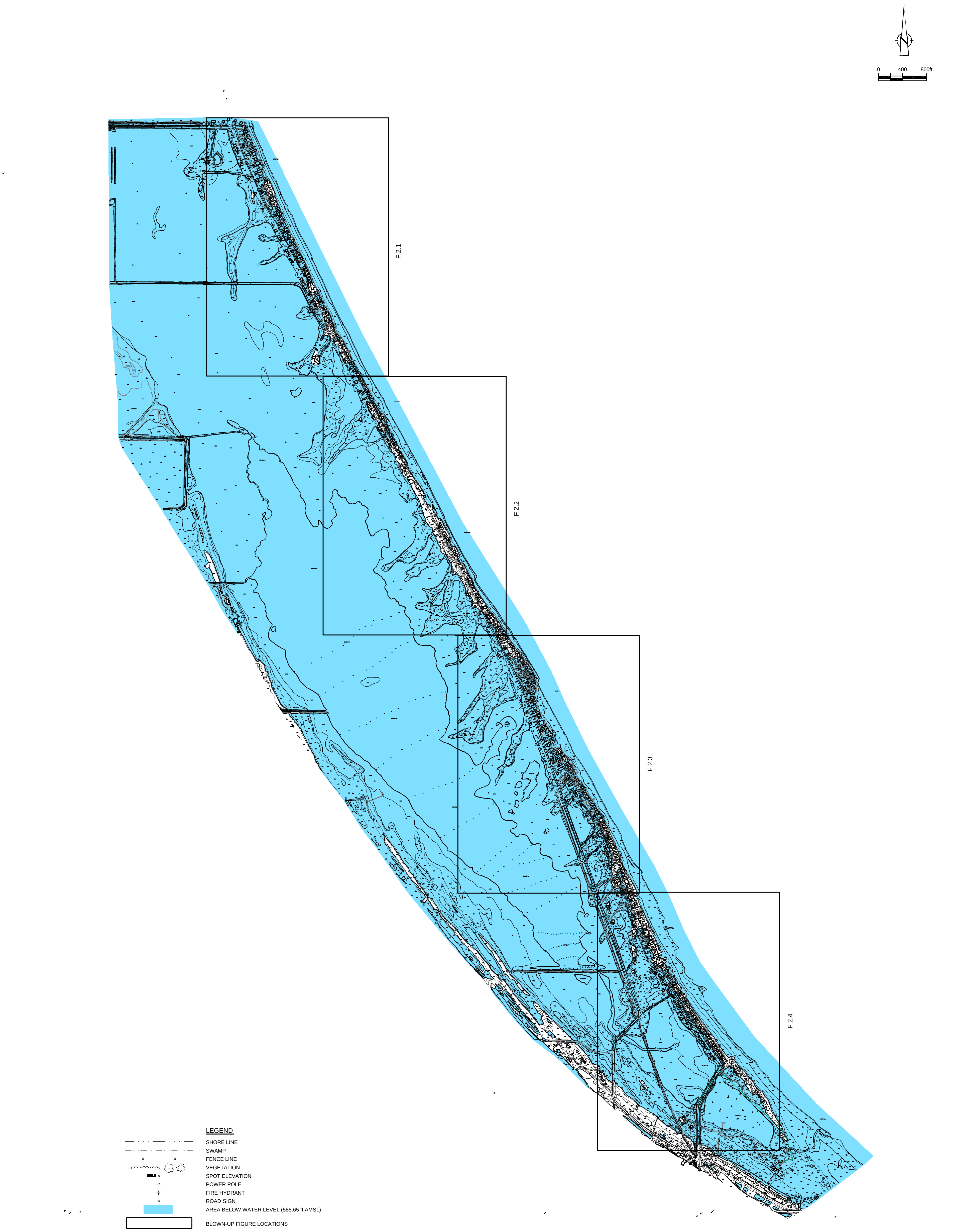
18204-03(013)GN-WA010 OCT 01/2004



LEGEND

SHORE LINE
SWAMP
FENCE LINE
VEGETATION
586.5 × SPOT ELEVATION
POWER POLE
FIRE HYDRANT
ROAD SIGN
AREA BELOW WATER LEVEL (585.65 ft AMSL)
FIGURE 2.3 BLOWN-UP FIGURE LOCATIONS

Nº	Revision	Date	Initial

SCALE VERIFICATION

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Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

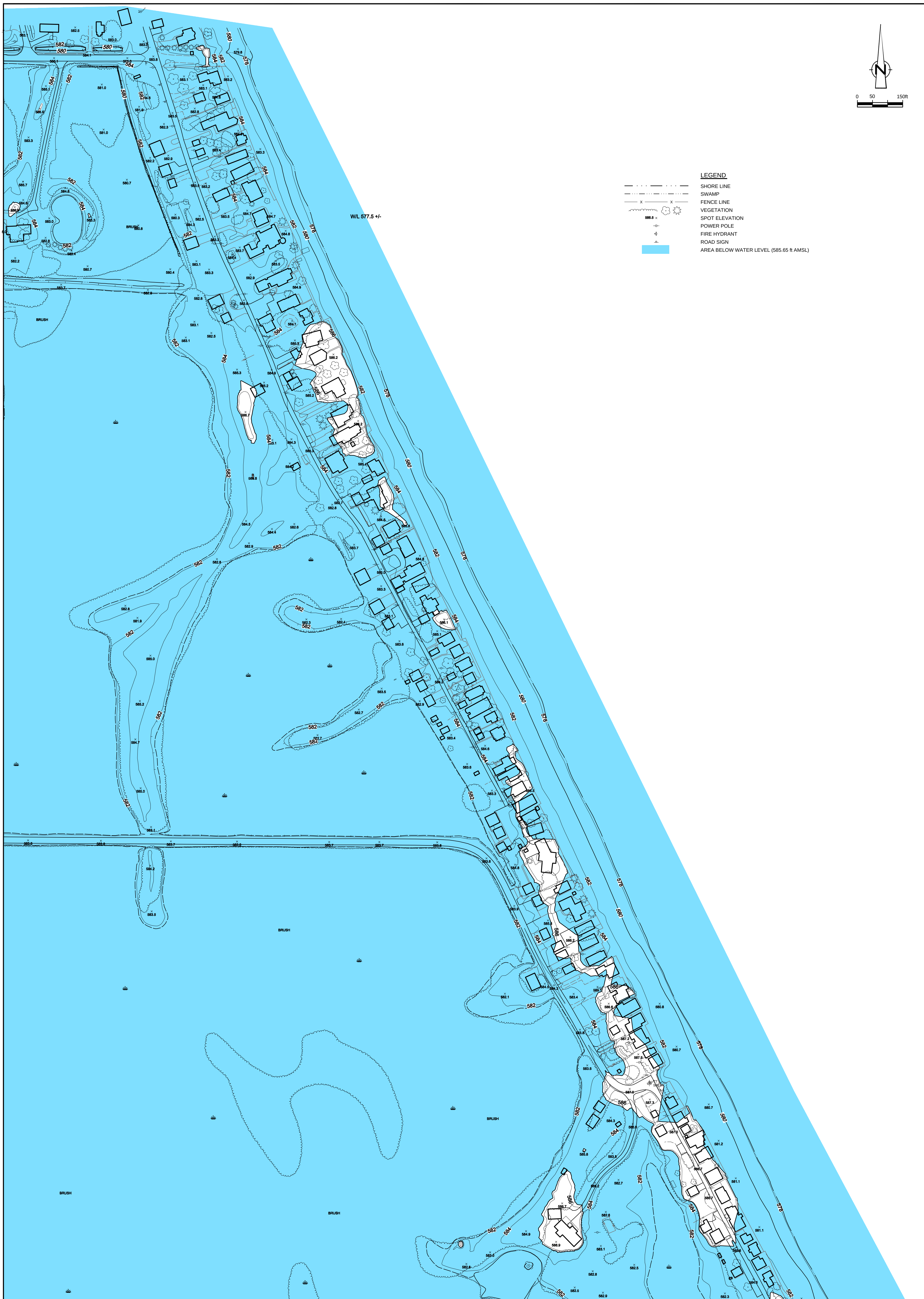
AREA OF FLOODING UNDER
100-YEAR FLOOD LEVEL (585.65)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

Project Manager:	Reviewed By:	Date:	
M. TOMKA	C. AMEY	OCTOBER 2004	
Scale: 1" = 800'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 2.0

18204-03(013)GN-WA011 OCT 01/2004



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Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

AREA OF FLOODING UNDER 100-YEAR FLOOD LEVEL (585.65)

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

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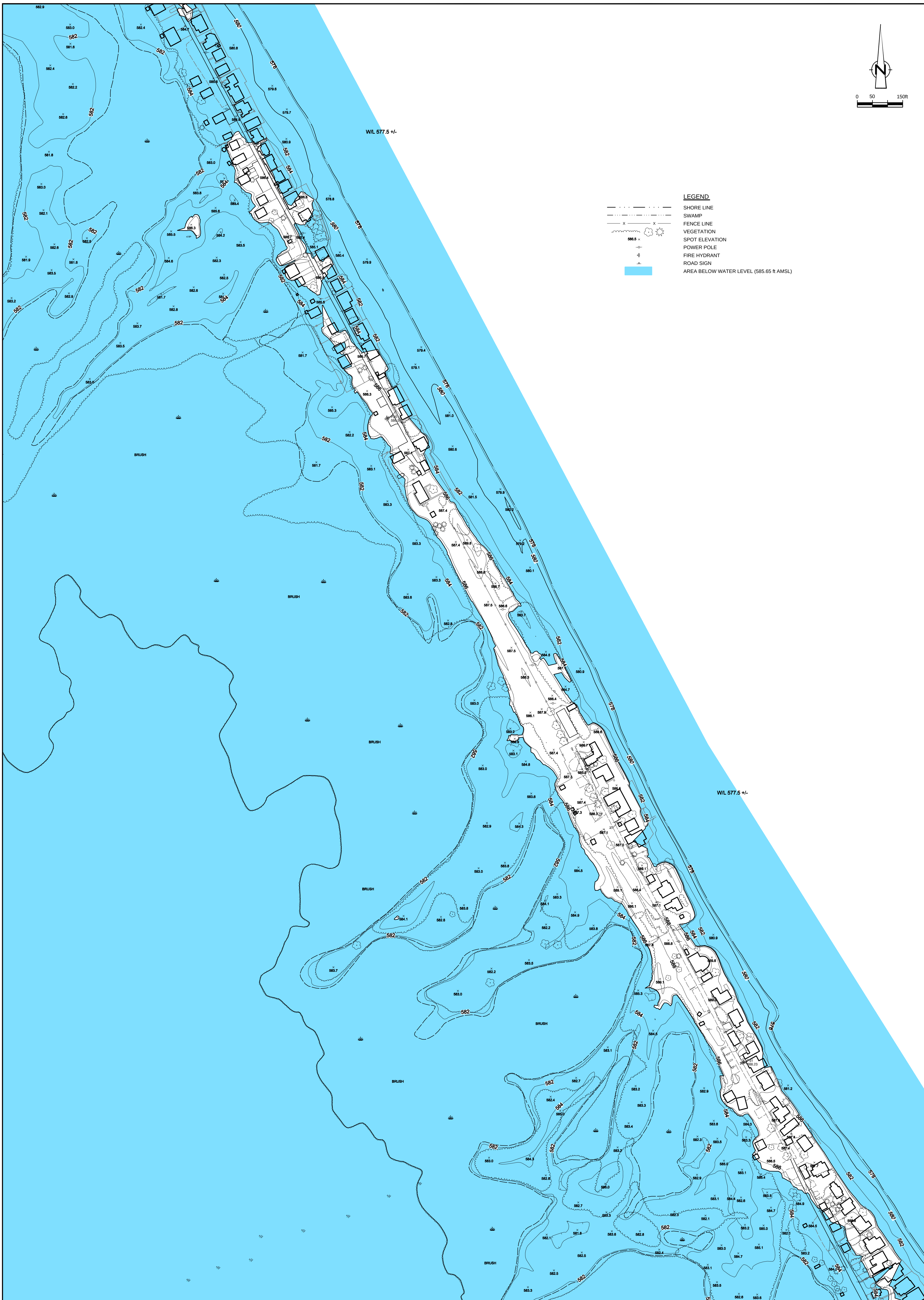
18204-03(013)GN-WA011 OCT 01/2004



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Approved

TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

AREA OF FLOODING UNDER
100-YEAR FLOOD LEVEL (585.65)

CONESTOGA-ROVERS & ASSOCIATES

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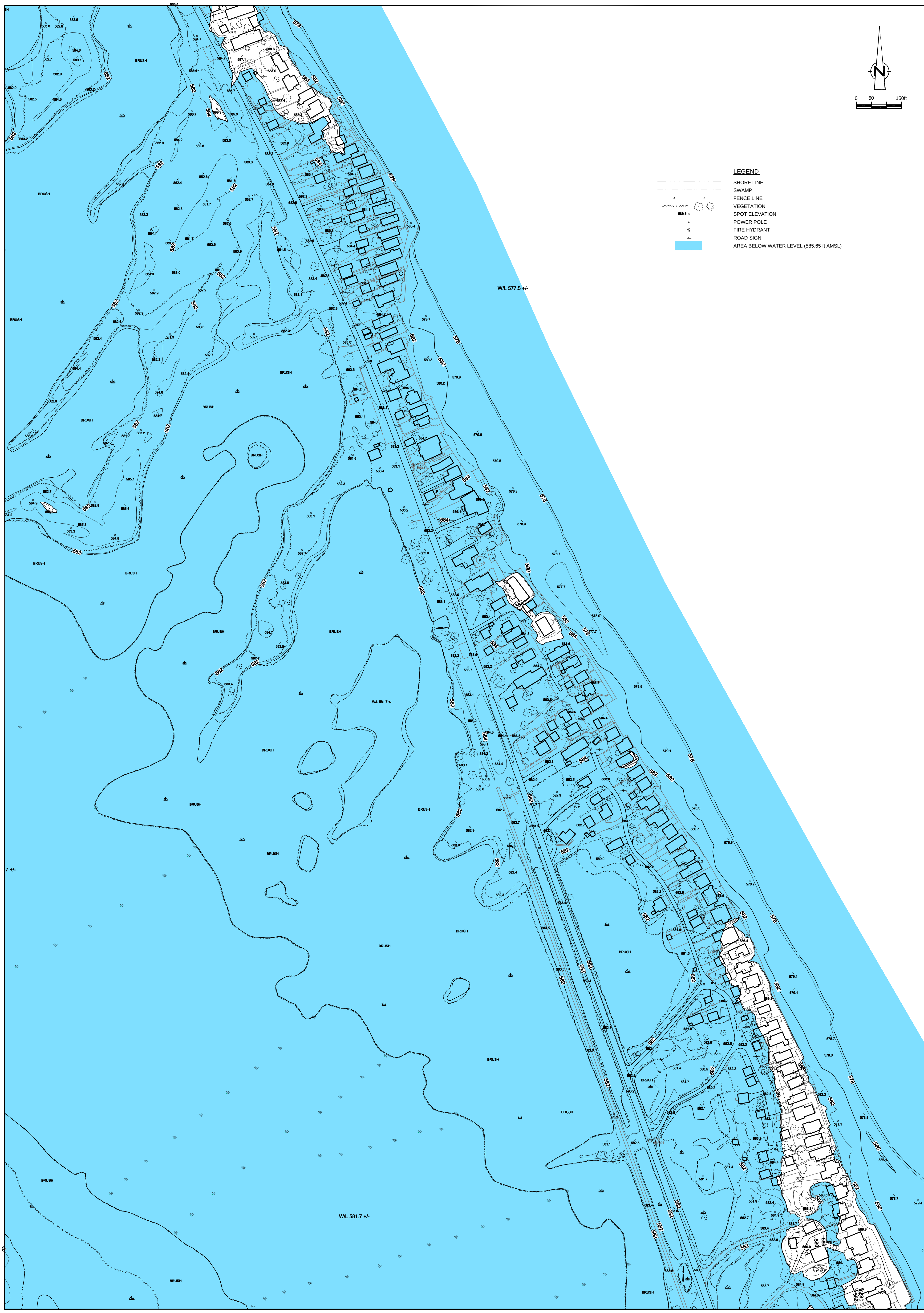
18204-03(013)GN-WA011 OCT 01/2004



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TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

AERA OF FLOODING UNDER
100-YEAR FLOOD LEVEL (585.65)

CONESTOGA-ROVERS & ASSOCIATES

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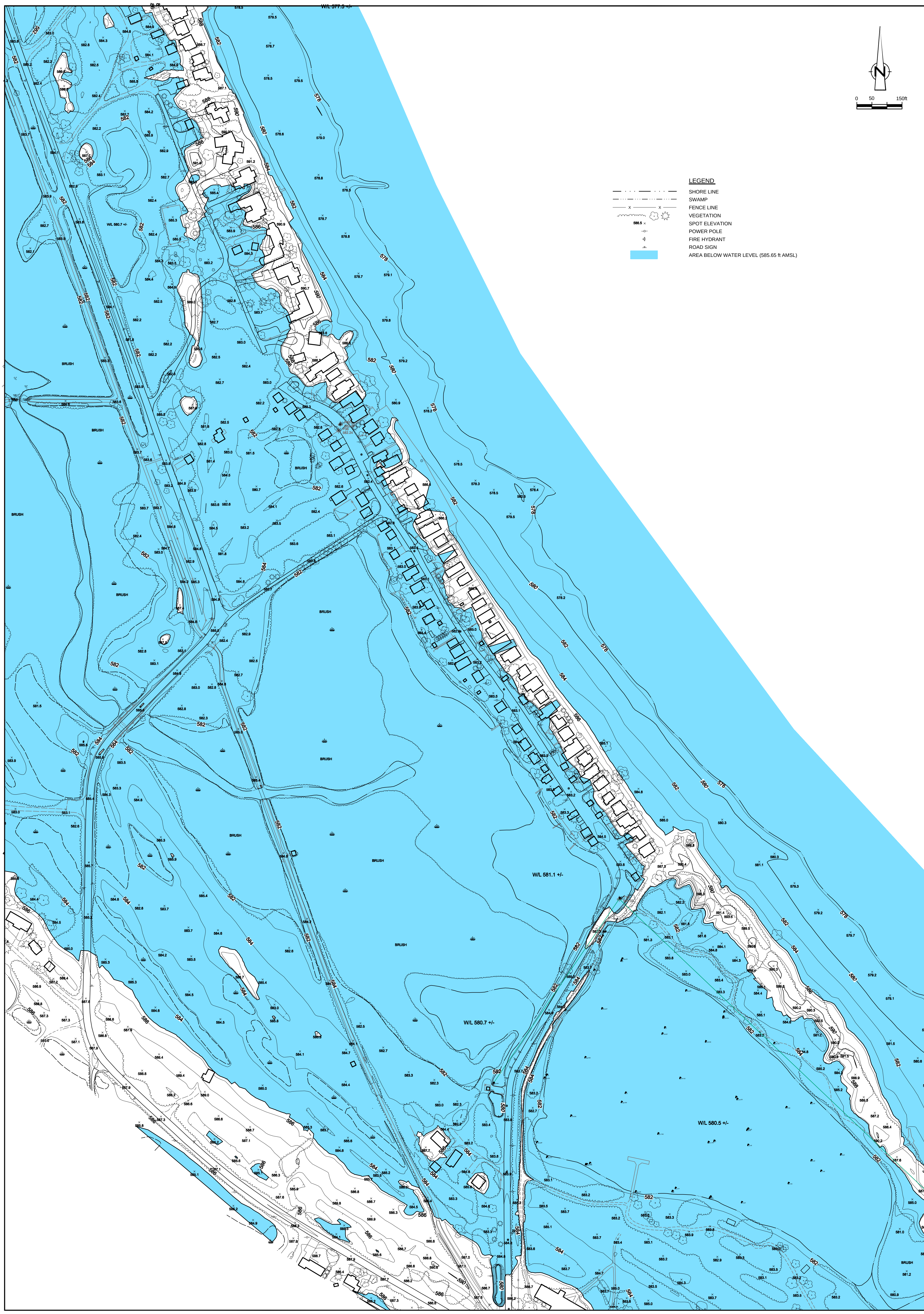

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TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

AREA OF FLOODING UNDER
100-YEAR FLOOD LEVEL (585.65)

CONESTOGA-ROVERS & ASSOCIATES

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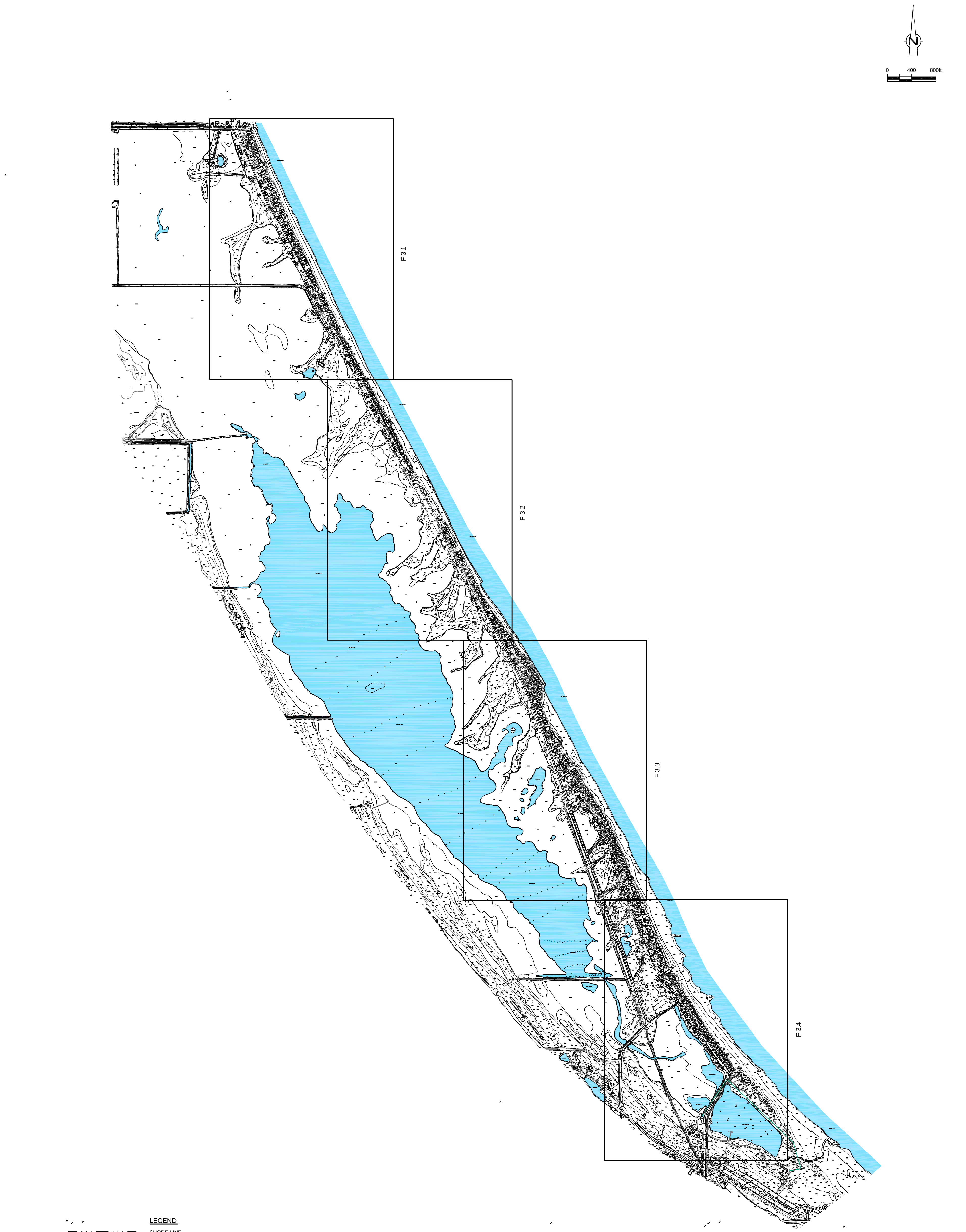
18204-03(013)GN-WA011 OCT 01/2004



LEGEND

SHORE LINE
SWAMP
FENCE LINE
FIELD LINE
TRAIL
CURRENT AREA OF OPEN WATER
BLOWN-UP FIGURE LOCATIONS

FIGURE 3.3

Nº	Revision	Date	Initial

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

SAGINAW RIVER/BAY NRD SETTLEMENT

TOBICO MARSH 50% PLAN

CURRENT OPEN WATER

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: ADVANCED MAPPING TECHNOLOGIES, MAY 4, 2002

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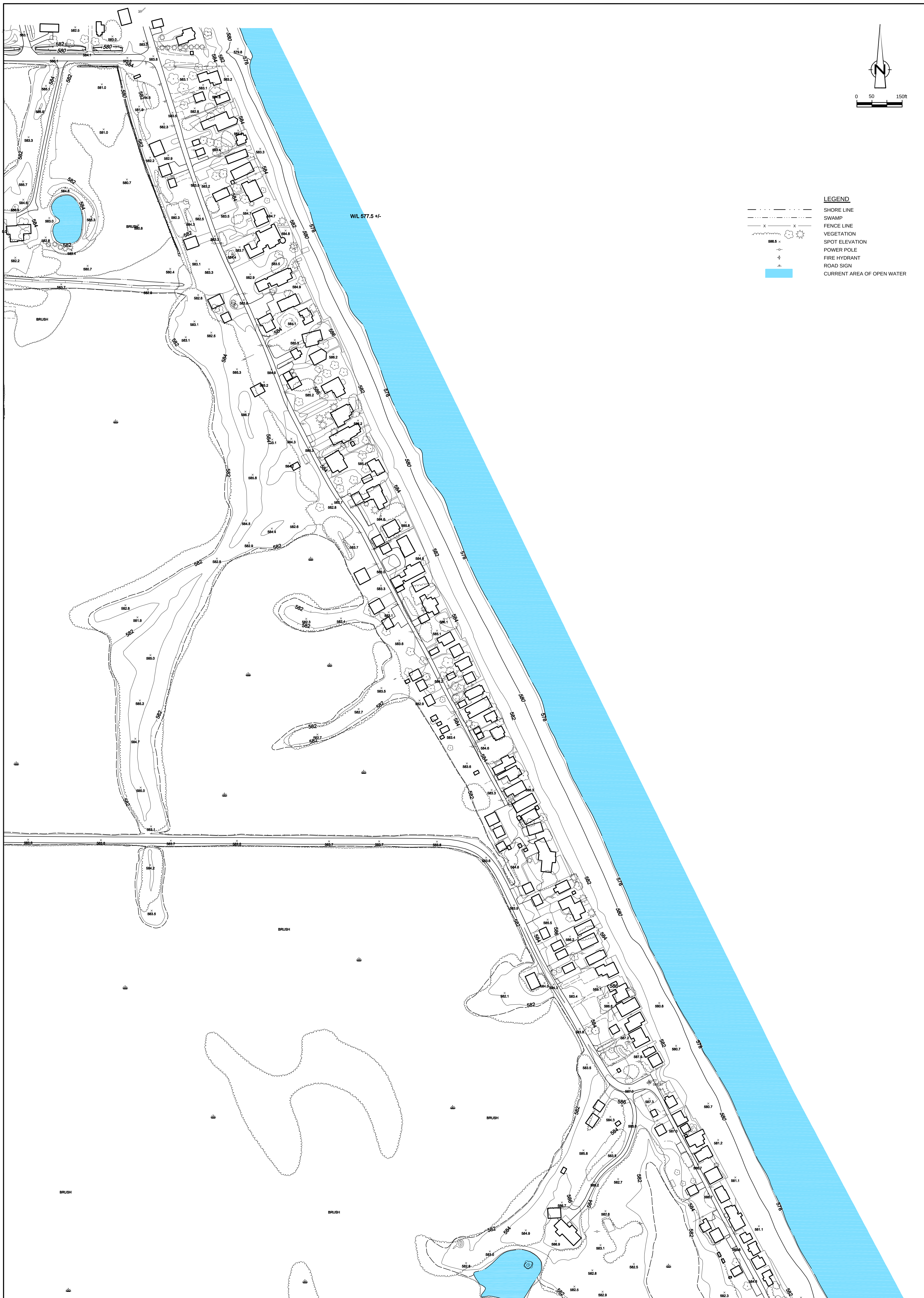
Scale: 1" = 800'	Project Nº: 18204-03	Report Nº: 013	Drawing Nº: F 3.0

18204-03(013)GN-WA012 OCT 01/2004



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TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

CURRENT OPEN WATER

CONESTOGA-ROVERS & ASSOCIATES

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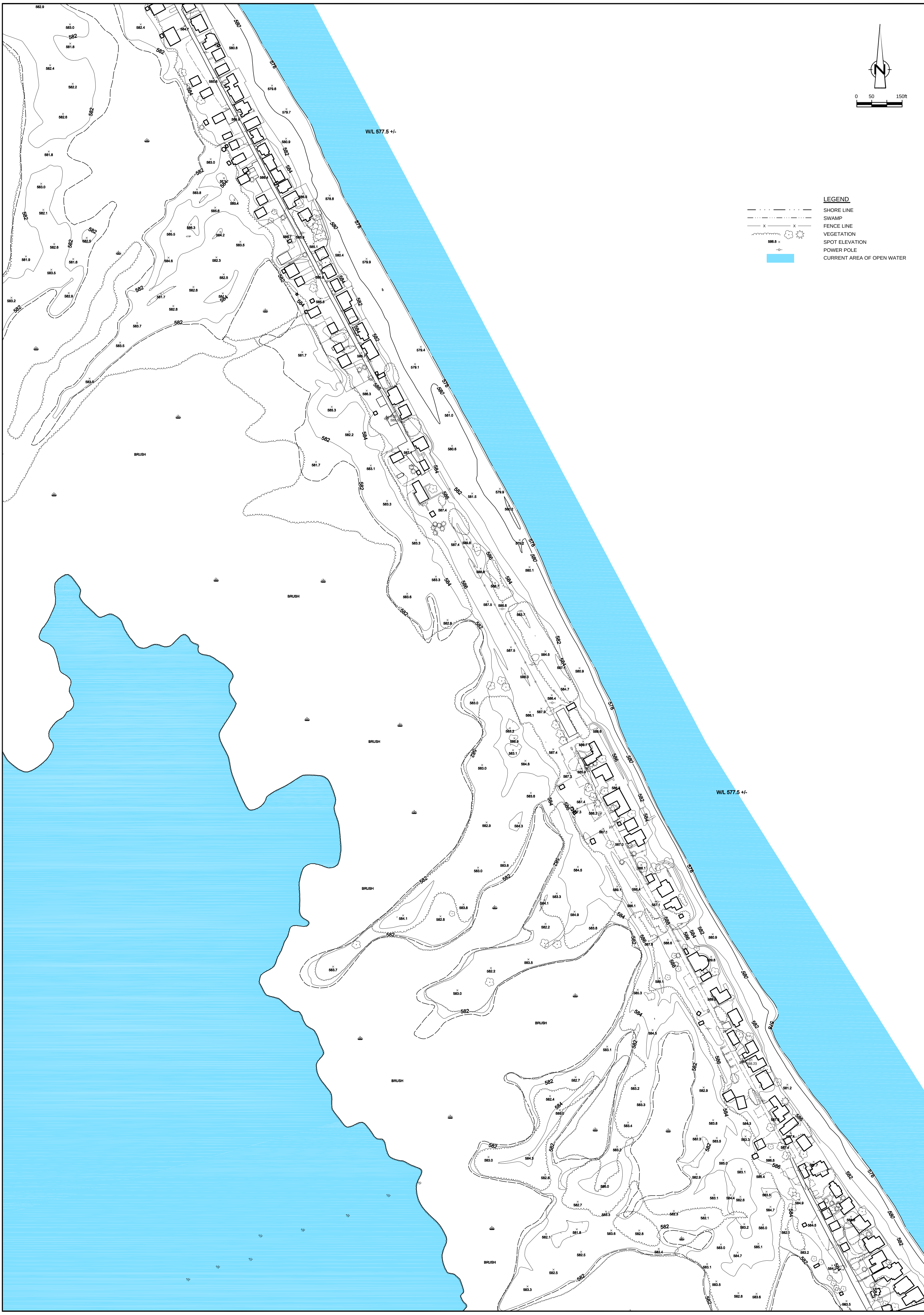
18204-03(013)GN-WA012 OCT 01/2004



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TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

CURRENT OPEN WATER

CONESTOGA-ROVERS & ASSOCIATES

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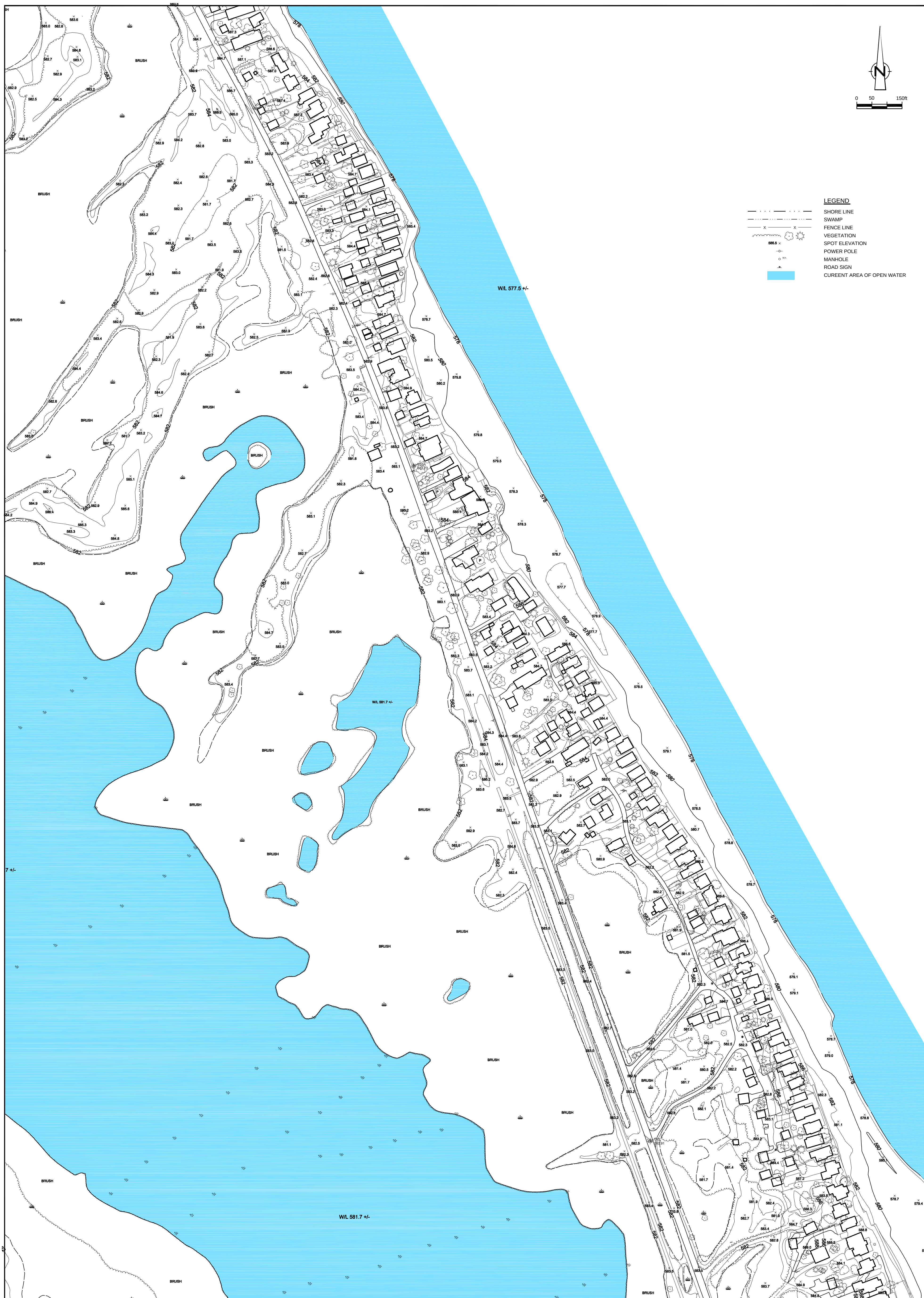

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TOBICO MARSH AERIAL
SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

CURRENT OPEN WATER

CONESTOGA-ROVERS & ASSOCIATES

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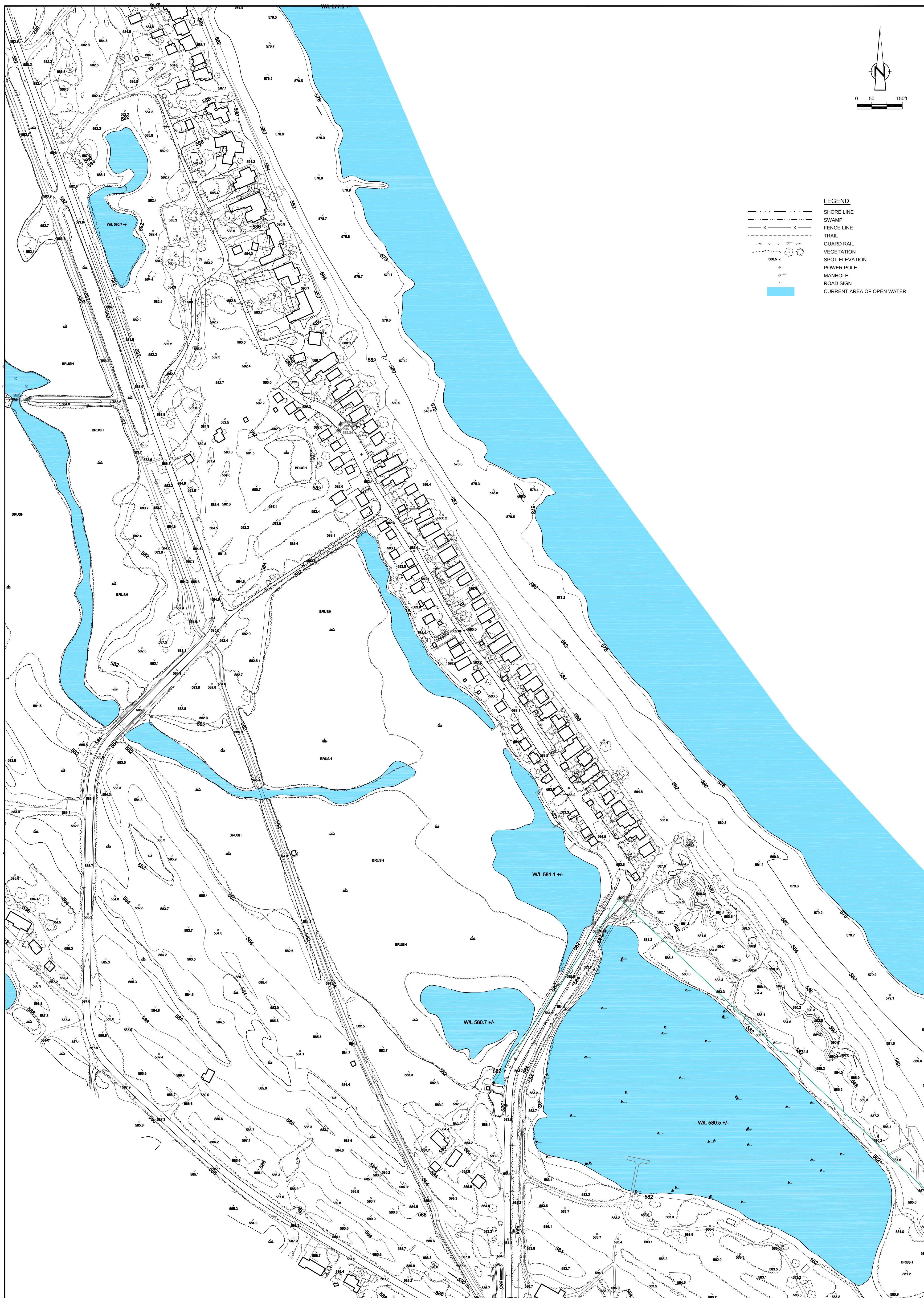

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SAGINAW BAY, MICHIGAN

SAGINAW RIVER/BAY NRD SETTLEMENT

CURRENT OPEN WATER

CONESTOGA-ROVERS & ASSOCIATES

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1" = 150'	18204-03	013	F 3.4

18204-03(013)GN-WA012 OCT 01/2004

APPENDIX G

INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION

APPENDIX H

STATE HISTORIC PRESERVATION REVIEW

STATE OF MICHIGAN

JENNIFER GRANHOLM
GOVERNOR

DEPARTMENT OF HISTORY, ARTS AND LIBRARIES
LANSING

DR. WILLIAM ANDERSON
DIRECTOR

Rec'd CRA
JAN 15 2004

January 7, 2004

LISA WILLIAMS
U S FISH AND WILDLIFE SERVICE
2651 COOLIDGE ROAD SUITE 101
EAST LANSING MI 48823

RE: ER-04-43 Resource Restoration – Fisheries Habitat Improvement, Tobico Marsh, Sections 12 & 13, T15N, R4E, Sections 29 & 30, T15N, R5E, Kawkawlin Township and Bangor Township, Bay County (FWS)

Dear Ms. Williams:

Under the authority of Section 106 of the National Historic Preservation Act of 1966, as amended, we have reviewed the above-cited undertaking at the location noted above. Based on the information provided for our review, it is the opinion of the State Historic Preservation Officer (SHPO) that **no historic properties are affected** within the area of potential effects of this undertaking.

Please be aware that although no historic properties will be affected by this undertaking, the State Archaeologist, Dr. John Halsey, notes that known archaeological resources do exist in the vicinity of the project that were not identified in your project submission. Keep in mind that it is the responsibility of the federal agency or their delegated authority to identify historic properties in area of potential effects. Likewise, for all projects submitted for review under Section 106 you must describe steps taken to identify historic properties, including the level of effort made to carry out such steps.

The views of the public are essential to informed decision making in the Section 106 process. Federal Agency Officials or their delegated authorities must plan to involve the public in a manner that reflects the nature and complexity of the undertaking, its effects on historic properties and other provisions per 36 CFR § 800.2(d). We remind you that Federal Agency Officials or their delegated authorities are required to consult with the appropriate Indian tribe and/or Tribal Historic Preservation Officer (THPO) when the undertaking may occur on or affect any historic properties on tribal lands. **In all cases**, whether the project occurs on tribal lands or not, Federal Agency Officials or their delegated authorities are also required to make a reasonable and good faith effort to identify any Indian tribes or Native Hawaiian organizations that might attach religious and cultural significance to historic properties in the area of potential effects and invite them to be consulting parties per 36 CFR § 800.2(c-f).

This letter evidences the Fish and Wildlife Service's compliance with 36 CFR § 800.4 "Identification of historic properties", and the fulfillment of the Fish and Wildlife Service's responsibility to notify the SHPO, as a consulting party in the Section 106 process, under 36 CFR § 800.4(d)(1) "No historic properties affected".

The State Historic Preservation Office is not the office of record for this undertaking. You are therefore asked to maintain a copy of this letter with your environmental review record for this undertaking. If the scope of work changes in any way, or if artifacts or bones are discovered, please notify this office immediately.

If you have any questions, please contact Brian Grennell, Environmental Review Specialist, at (517) 335-2721 or by email at ER@michigan.gov. **Please reference our project number in all communication with this office regarding this undertaking.** Thank you for this opportunity to review and comment, and for your cooperation.

Sincerely,

Martha L. MacFarlane

Martha MacFarlane Faes
Environmental Review Coordinator

for Brian D. Conway
State Historic Preservation Officer

MMF:JRH:ALA:bgg

Copy: Mike Tomka, Conestoga-Rovers & Associates